CSMM CENTER FOR SUSTAINABLE MATERIALS MANAGEMENT

ESF State University of New York College of Environmental Science and Forestry

New York State
Center for Sustainable Materials Management

at the

State University of New York
College of Environmental Science and Forestry

Final Report for:

New York State Department of Environmental Conservation
Product Stewardship and Waste Reduction Section

Effectiveness of the NYS Mercury Thermostat Collection Act of 2013 with Recommendations for the Act's Extension

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Disclaimer

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Definitions

- Department - The state department responsible for overseeing Mercury Thermostat collection.
- Retailer - A person or Business that sells thermostats primarily to Consumers.
- Wholesaler - A person or company that primarily sells thermostats to Contractors.
- Consumer - An individual that purchased and is responsible for the disposal of a thermostat.
- Contractor - A Person or company in the business of servicing the heating systems in homes.
- Manufacturer - A Person that owns or owned a brand of mercury thermostats.
- P-value - A p-value is the probability that a particular statistic will be greater than or equal to the observed results. In null-hypothesis testing, the p-value is the probability of obtaining the observed statistic (e.g., mean or median) under the null hypothesis
- Kruskal-Wallis H Test - A non-parametric (non-normal distribution) alternative to the one-way analysis of variance (ANOVA). Unlike a one-way ANOVA that tests for significant differences between group means, the H test is used to identify significant differences between group medians. The H test yields a p-value that indicates if there are significant differences between groups as a whole

Abbreviations

- DEC - New York Department of Environmental Conservation
- 2013 MTCA - New York State Mercury Thermostat Collection Act of 2013
- TRC - Thermostat Recycling Corporation
- SERA - Skumatz Economic Research Associates
- NYS - New York State
- PSWR - The Product Stewardship and Waste Reduction Section
- ANOVA - Analysis of Variance
- MT - Mercury Thermostat
- EPR - Extended Producer Responsibility
- CET - Center for EcoTechnology

Executive Summary

The Product Stewardship and Waste Reduction Section (PSWR) of the New York State (NYS) Department of Environmental Conservation (DEC) has tasked the Center for Sustainable Materials Management (CSMM, or "the Center" hereafter) to perform an effectiveness study on the NYS Mercury Thermostat Collection Act of 2013 (MTCA). CSMM was requested to perform the following:

- **Task 1**: Perform a literature review to ascertain the veracity of the Thermostat Recycling Corporation (TRC) and Skumatz Economic Research Associates (SERA) reports.
- **Task 2**: Based on annual report data as well as available state agency reports from all states in which TRC operates, assess the impact of the implementation of contributing factors on collection results.
- **Task 3**: Propose realistic annual collection goals beginning with the 2023 calendar year and suggest a future sunset date and any changes to the 2013 MTCA.

In order to protect the health of New Yorkers and safeguard our environment, there is a continued need for a NYS mercury thermostat collection program. **CSMM recommends that the current New York State 2013 Mercury Thermostat Collection Act not sunset and be extended to at least 2045.** To form this conclusion, CSMM conducted an analysis into the 2014 SERA report to determine that the results of the report can be utilized to set future collection goals. Based on the SERA reports, TRC is only capturing 7% of the thermostats removed, which equates to 693 pounds of mercury being disposed of improperly every year. CSMM benchmarked other states, including Maine, California, Vermont, and Illinois, and determined there are opportunities for NYS to enhance this law in a proposed extension. CSMM recommends that to improve collection rates in NYS the Department of Environmental Conservation, in collaboration with Thermostat Recycling Corporation, **should enhance its outreach efforts and convenience measures as well as implement a financial incentive program.**

Introduction

The first mercury thermostat was invented around 1620.[1] They are an extremely valuable household invention, providing convenient and efficient cooling and heating. Modern mercury thermostats (MTs) were manufactured to last 30-50 years. A conservative estimate indicates that the most recently installed MTs could remain in service through 2065.[2]

Mercury is now widely recognized as a hazardous chemical. The EPA defines mercury as a neurotoxin that damages the nervous system. Humans may encounter mercury in two forms – elemental mercury and methylmercury, both forms may cause significant health effects, see Box 1. Both forms cause greater damage to unborn fetuses and children as their nervous systems are more vulnerable while developing[3].

Box 1: Symptoms elemental mercury and methylmercury exposure[3]

> Symptoms of **elemental mercury** exposure include: *tremors,emotional changes (such as mood swings, irritability, nervousness, excessive shyness), insomnia, neuromuscular changes (such as weakness, muscle atrophy, twitching), headaches, disturbances in sensations, changes in nerve responses, and/or poor performance on tests of mental function.*
>
> Symptoms of **methylmercury** exposure include: *loss of peripheral vision, lack of coordination of movements, impairment of speech, hearing and walking, muscle weakness.*

It is imperative that mercury thermostats do not end up in the regular waste stream. Inside of the thermostats are glass switches that contain the mercury. These switches can be easily broken if disposed of improperly, e.g in the environment or in the regular waste stream. Broken switches release elemental mercury and elemental mercury vapor at room temperature.[4] The vapor or liquid mercury easily leaches from the regular waste stream into the surrounding environment. When elemental mercury enters a body of water, bacteria convert it to methyl mercury. Through bioaccumulation, methylmercury is absorbed and concentrated into organisms, magnifying to higher concentrations as it moves up the food chain. Through consumption of these aquatic organisms, humans can be exposed to harmful concentrations of methylmercury.[4]

In 1998, MT manufacturers voluntarily created and funded the Thermostat Recycling Corporation (TRC), to help manage the disposal process nationwide.[2,3] On a national level, TRC provides bins, advertising, and educational materials to locations that volunteer to be collection sites. In 2001, states started to ban the sale of MTs. Between 2004 and 2007, thermostat manufacturers halted MT production, and by 2015 manufacturer stocks of mercury thermostats were depleted[5]. In 2005, under the NYS Mercury Added Consumer Products Law, mercury thermostats were banned from the regular waste stream, but more needed to be done.

Maine passed the first MT extended producer responsibility (EPR) legislation in 2006. This act provided Maine's government with the ability to oversee TRC's efforts and required them to provide a financial incentive, yearly reports, and more. In the next ten years, 13 additional states passed MT EPR acts. Many of these laws are set to sunset in the next five years without legislative amendment,

including the New York State Mercury Thermostat Collection Act of 2013[5]. This law is due to sunset January 1, 2024.

Project Objective

The objective of this report is to provide the New York State Department of Environmental Conservation with recommendations to enhance mercury thermostat recycling in New York State. This recommendation includes financial incentives, supporting policy, setting collection goals, outreach and education strategies, and outlining the need for a supplementary study.

Work Performed and Results

Task 1. Literature review and summary of mercury thermostat collection reports and estimated thermostat expiration in New York

Methods

To understand the effectiveness of the New York State (NYS) Mercury Thermostat Collection Act of 2013 (MTCA), a review of the available estimates of expired mercury thermostats (MTs) and reports of MT recovery was performed. The NYS Department of Environmental Conservation (DEC) oversees the Thermostat Recycling Corporation (TRC) in its provision of a mercury thermostat collection program in the state and annually reviews TRC's program results[6]. In 2015, the Skumatz Economic Research Associates (SERA) performed a study estimating the number of MTs in NYS and the annual outflow of MTs over time.[7] The data and reports from TRC and SERA are the primary resources used in this study to describe MT collection trends in NY.

Since 2014, TRC published an annual report that includes a description of MT collection rates, an evaluation of program performance, and summaries of program expenses, education and outreach efforts, and modifications made to the program that year. Collection rates were reported as the total number of whole thermostats, loose mercury switches, and pounds of mercury (Hg lb). All metrics were summarized as the total collected in the state, by county, by collection site type, and at each collection site.

TRC reporting was at times difficult to understand or lacked scientific accuracy. In all of TRC's charts the amount of mercury was labeled as a volume rather than a weighted measurement. There may have been a reason for TRC to choose volume as a measurement, but it was not clear based on the charts and information available[8]. TRC reporting system has a list of all the current sites by state. This list includes information for all locations with collection bins, including those that have not returned a bin in the past year. For our purposes, CSMM is considering sites that have returned at least one bin in the past year as "active" sites. This is reflected as 'site density' throughout the report. Over the past five years, there has been an average of 149 active sites in New York State. However, currently there are 495 total collection sites in New York State. Although many of these locations have not returned a bin in the past year, they are still actively willing to participate in the program. TRC should work with these locations to improve their outreach and advertising efforts to local communities to improve collections from these locations.

The objective of the SERA report was to estimate the number of MTs installed in NY, when these MTs would expire, and the outflow of the expired MTs in the state over time. To fulfill this

objective, SERA implemented a survey to randomly-selected owners of commercial buildings, single-family homes, and multi-family homes throughout the state, following the industry standard method. Recognizing the different housing and commercial building characteristics between New York City (NYC) and the rest of the state (ROS), SERA performed a simple random sample of households and a stratified sample of businesses on these groups (NYC and ROS) to obtain a representative sample. SERA chose to stratify businesses by employment size as a proxy for size of the commercial building, to "recognize the complexity and potential differentiation" within this sector. This decision was based on the findings of a previous study that found the number of thermostats varied with the year built, remodel year, square footage, and dominant building use of commercial buildings.[7] SERA also estimated the outflow of expired MTs each year using the survey responses followed by in-person visits to a random sample of respondent's buildings to estimate the survey's margin of error and revised the estimates based on these findings.

To verify the estimates provided by SERA, CSMM reviewed the methods used in the study with consideration of public critiques by TRC and other organizations. Many organizations, including TRC, have criticized the accuracy of the SERA reports due to concerns with their sampling methods and the resulting sample sizes and response rates.[7,9-11] The Center's key concern with the methods used by SERA was their "implicit assumption was that single-family homes were fairly homogeneous, and there was no particular reason, *a priori*, to assume that there were systematic differences in the lifetimes of thermostats in place in single family homes around the State" followed by a footnote explaining "if there were, we would uncover it as part of the work; it was not something known ahead of time in a way that would support complex residential sampling. In energy end-use surveys, the residential sector is rarely stratified beyond single- vs. multi-family".[7] Although it was uncommon to stratify the residential sector beyond single- and multi-family homes, we found this assumption surprising given their reasoning for stratification of the commercial sector - building size, with evidence that other factors (building age, etc.) were also found to relate to variations in the number of thermostats. Following the same line of thinking, we chose to test their assumption by applying our hypothesis that homes are not homogenous with respect to size, age, and household income throughout NYS. These metrics were chosen based on our assumption that significant differences between regions by these factors could impact the estimated quantity of MTs in the state and the estimated outflow of expired MT over time (Box 2). Therefore, stratifying single- and multi-family homes by region could ultimately yield a more accurate estimate of the total number of MTs and the outflow of expired MTs in the state.

Box 2: CSMM assumptions for the variables used to test the assumptions of the SERA report

Variable	**Assumption**
Average Home Age are *(structure)*	Counties and regions with a higher number of old housing structures more likely to contain a greater number of mercury thermostats than areas with newer homes
Average Rooms per Home (proxy for home size)	Counties and regions with a higher number of larger homes (more rooms per home) are more likely to contain a greater number of thermostats than areas with smaller homes (fewer rooms per home)
Average Household Income	Counties and regions with a higher average household income are likely to have larger and newer homes, therefore 1) are likely to contain a greater number of thermostats per home than areas with lower household incomes, and 2) are more likely to have a faster outflow of mercury thermostats since households with more income have a greater ability and desire to replace these for modern thermostats

CSMM performed the Kruskal-Wallis H test on housing characteristics including average age of home (structure), average number of rooms (as a proxy for housing structure size), and average household income per county between New York State regions and between the SERA-defined sections of the state (NYC and ROS) using data from the US Census.[12-14] CSMM researchers tested for significant differences between regions to check if the homogeneity assumption held true. This test was performed by grouping by region, rather than by county, as a more feasible application of the stratified sampling method, while achieving a higher level of accuracy than the SERA grouping (NYC and ROS) since more variation is taken into account. The Kruskal-Wallis H test is a non-parametric alternative to the one-way analysis of variance (ANOVA). This test was conducted since much of the data does not fit a normal distribution, such as household income and rooms per home (See *Appendix I*). Unlike a one-way ANOVA that tests if the means are different between groups, the H test tests for differences in group medians. The H test yields a p-value that indicates if there are significant differences between groups as a whole. A post-hoc test is then run to identify which specific groups are significantly different from one another. Box-and-whisker plots are then generated to show the distribution of housing characteristics between groups.

The other potential issue found is the low response rate and number of responses from each surveyed category (Table 1). Response rate alone cannot tell us if the sample obtained is large enough to generate a statistically valid estimate. Recognizing that the response rate to a voluntary survey will be low, SERA correctly accounted for this by sending the survey to a large enough number of businesses, single-family homes, and multi-family buildings. All sample sizes (responses received), except for the number of responses received from small businesses in NYC, were large enough for SERA to estimate with 90% confidence and a +/- 10% margin of error, given the values listed in Figure 2.1 of the SERA report (Tables 1 and 2). It is optimal to obtain samples large enough to estimate the

quantity and outflow of MTs in the state with 95% confidence and a +/-5% margin of error. However, no group of samples obtained by SERA were large enough for this level of accuracy, but the accuracy obtained is greatly acceptable.

Table 1: Number of residential and commercial units, number of surveys sent, number of responses, and the response rate in New York City (NYC) and the Rest of the State (ROS) from the SERA study.

Category	**Census Units & Establishments**		**Number of Surveys Sent**		**Number of Responses**		**Response Rate**	
	NYC	ROS	NYC	ROS	NYC	ROS	NYC	ROS
Single-Family Homes	556,000	3,466,000	5,000	5,000	288	296	5.8%	5.9%
Multi-Family Homes	2,838,000	1,266,00	6,750	6,750	237	232	3.5%	3.4%
Small Businesses	169,000	195,000	4,000	4,000	**55***	83	1.4%	2.1%
Large & Medium Businesses	46,000	113,000	5,383	8,125	195	144	3.3%	1.8%
Total	***3,608,000***	***5,039,000***	***21,588***	***23,875***	***775***	***755***	***3.6%***	***3.2%***
*: Sample size too small to achieve 90% confidence with +/- 10% margin of error, samples needed: 68 (See Table 2).								

Table adapted from Figures 2.3 and 2.4 from the SERA Report.[7]

Table 2: Sample Size and Resulting Accuracy and Confidence in Responses

Population Size	**Responses needed for accuracy of…**			
	95% Confidence		90% Confidence	
	+/- 5%	+/- 10%	+/- 5%	+/- 10%
100	79	49	73	40
1,000	278	88	213	63

10,000	370	95	263	67
100,000	383	96	270	**68***
1,000,000	384	96	271	**68***
10,000,000	384	96	271	68

*: Sample size needed for NYC small businesses to achieve 90% confidence with +/- 10% margin of error. Sample size values for both 100,000 and 1,000,000 population sizes were highlighted since the population of small businesses in NYC is between these values.
Table adapted from Figure 2.1 from the SERA Report.[7]

When using estimates for the basis of a state-wide program it is important to use the most accurate information possible. Given that the estimates were generated using the industry standard sampling methods, they are sufficient for obtaining a representative sample for this method. However, there is still some room for concern about the potential impacts of a non-response bias due to their assumptions and relatively low response rates. Since there have been no efforts by SERA or other parties to check for differences between the response-and non-response groups, CSMM has decided to do so. There are limitations to the results of this analysis since we are comparing the qualities of the counties where no responses were collected rather than comparing the qualities of the exact homes and businesses that received the survey but did not respond. Since we do not have SERA's response data, we cannot say if these counties were omitted from the response group because they were not included in the random sample of homes and businesses where the survey was sent or if no respondents returned the survey from these counties. While this non-response analysis is not perfect, we believe it provides valuable insight into the accuracy of the estimated number of thermostats in the state and the estimated outflow rate over time provided by SERA.

Before being able to compare the response and non-response groups, CSMM first identified these groups and the qualities of the counties in them. This information was found using the charts in Appendix B in the SERA report.[7] No responses (both residential and commercial) were collected from 4 of the 62 counties in New York, representing a very small portion (0.85%) of the state's population (Table 3).

Table 3: Population, occupied housing units, and businesses of New York counties without responses to the SERA survey, data sources: SERA, 2015 and US Census[7,12-14]

County	**Region**	**Population** (2011-2015 Average)	**Occupied Housing Units** (2011-2015 Average)	**All Businesses** (2015)

Chenango	Southern Tier	49,527	19,641	2,783
Greene	Capital District	48,226	17,634	3,386
Lewis	North Country	27,047	10,539	1,601
Wyoming	Finger Lakes	41,394	15,787	2,363
Total	–	*166,194 (0.85%)*	*63,601*	*10,133*

No residential responses (both single-family and multi-family homes) were collected from 11 counties. These counties represent 2.83% of the state's population (554,553 people) and 3.28% of the state's homes (246,864 housing units) (Table 4). No commercial responses (small, medium, and large businesses) were collected from 15 counties. These counties represent 3.74% of the state's population (733,829 people) and 2.91% of the state's businesses (44,204 businesses). While these counties make up a relatively small portion of the state's population, housing units, and businesses, it is still important to check if there were differences between these counties (non-response group) and the response group. See *Appendix I* for the full list of counties without responses, this includes single- and multi-family homes separately.

Table 4: Population, single- and multi-family homes in New York counties without residential responses to the SERA survey, data sources: SERA, 2015 and US Census[7,12-14]

County	**Region**	**Population** (2011-2015 Average)	**Single-Family Homes** (2011-2015 Average)	**Multi-Family Homes** (2011-2015 Average)
Cattaraugus	Western NY	78,952	28,908	7,101
Chemung	Southern Tier	88,023	26,887	9,384
Chenango	Southern Tier	49,527	15,620	3,860
Greene	Capital District	48,226	22,444	4,488
Hamilton	North Country	4,759	7,753	139
Lewis	North Country	27,047	12,015	1,015

Livingston	Finger Lakes	64,640	19,329	5,176
Schuyler	Southern Tier	18,299	6,459	1,010
Seneca	Finger Lakes	35,140	11,540	2,258
Steuben	Southern Tier	98,526	33,053	8,477
Wyoming	Finger Lakes	41,394	13,819	2,953
Total	–	*554,533 (2.83%)*	*195,827 (2.60%)*	*51,037 (0.68%)*

Table 5: Population and businesses in New York counties without responses to the SERA survey, data sources: SERA, 2015 and US Census[7,12-14]

County	**Region**	**Population** (2011-2015 Average)	**Small Businesses**[1] (2015)	**Medium Businesses**[2] (2015)	**Large Businesses**[3] (2015)
Chenango	Southern Tier	49,527	1,589	1,131	63
Clinton	North Country	81,429	2,778	2,667	90
Columbia	Capital District	62,105	3,278	1,887	60
Delaware	Southern Tier	46,811	1,940	1,119	51
Franklin	North Country	51,237	1,570	1,293	36
Greene	Capital District	48,226	2,108	1,236	42
Herkimer	Mohawk Valley	63,706	1,921	1,365	42
Lewis	North Country	27,047	1,007	576	18
Schoharie	Mohawk Valley	31,946	998	689	18
Tioga	Southern Tier	50,087	1,478	921	33
Washington	Capital District	62,716	1,834	1,221	51
Wayne	Finger Lakes	92,343	2,995	2,136	96

Wyoming	Finger Lakes	41,394	1,316	1,008	39
Yates	Finger Lakes	25,255	953	638	15
Total	–	*733,829 (3.75%)*	*25,765*	*17,887*	*552*

1: Small businesses are defined as those with 1-4 employees[7]
2: Medium businesses " " with 5-99 employees[7]
3: Large businesses " " with 100+ employees[7]

To test if the residential sector response and non-response groups were significantly different CSMM performed the Kruskal-Wallis H test on the same housing characteristics (home age, number of rooms, and household income) between response groups using data from the US Census.[12-14] These metrics were chosen based on our same hypotheses used to test the SERA assumption (Box 2). If significant differences between the response and non-response groups exist, then the estimated number of MTs and the outflow rate of MTs over time in the state is likely inaccurate.

Box 3: CSMM Assumptions for the variables used to test for non-response bias in the SERA study

Variable	**Assumption**
Number of Small Businesses	Counties with a greater number of small businesses are more likely to have fewer thermostats than counties with a higher number of medium and large businesses
Number of Medium and Large Businesses	Counties with a greater number of medium and large businesses are more likely to have a greater number of thermostats than counties with a higher number of small businesses

Results

The 2015 SERA report is the only baseline for NYS for the estimated number of MTs and the anticipated outflow of expired MTs over time. Although many organizations have criticized the accuracy of the SERA reports, CSMM recognizes that much of these critiques were shared without subsequent verification of their claims.[9-11] CSMM recognizes that performing state-wide survey research and studies that produce estimates for such large populations are rarely going to be perfectly accurate, regardless of how well the study is conducted. Therefore, it is important to note the high quality of work performed by SERA, specifically, the quality of the survey instrument design,

the steps taken to ensure the validity of the data collected, and the data analysis.[7] It is also important to reiterate that results of the SERA report are accurate with respect to the sampling design used and adequately represents the sample obtained in the study. We recognize that the study was conducted using industry standard methods and was considered appropriate for the information and resources available at the time.

Testing the SERA Assumption

Although it was rare for the residential sector to be stratified beyond single- and multi-family homes, per industry standard, we found evidence that suggests that stratifying the residential sector also by region (see Figure 1) would not only increase the sample size - a common concern, but could also improve the accuracy of the estimated number of MTs in the state and their outflow overtime, by reducing the effect of non-response bias.

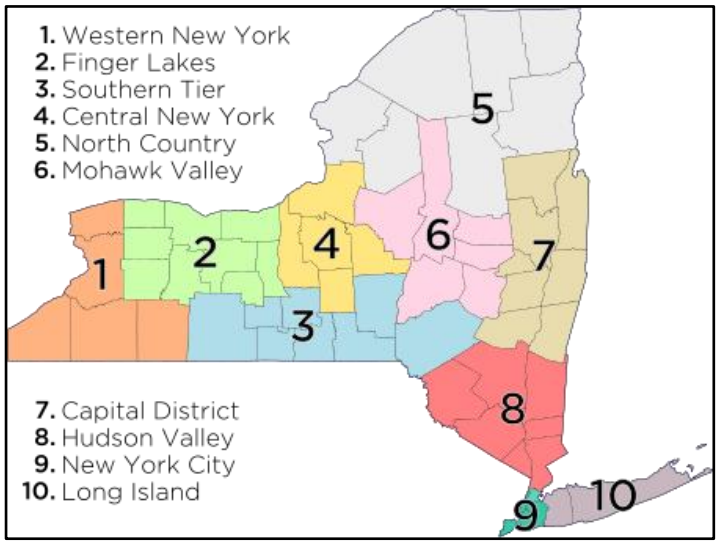

Figure 1: New York State Regions
Source: New York State Department of Economic Development.[16] *Image: Wikipedia.*[17]

The results of Kruskal-Wallis tests showed that there are significant differences between NYS regions for the average age of homes (structure), average rooms per home (proxy for housing structure size), and average household income (Table 6). The results also showed that there were significant differences between the SERA-defined groups, NYC and ROS, for average age of home and average rooms per home, but not for average household income (Table 6). The Kruskal-Wallis test was used to test the null hypothesis that the 1) Average Home Age, 2) Average Rooms per Home, and 3) Average Household Income were the same across NYS regions.[17] A p-value less than 0.05 indicates that there are significant differences in these metrics between regions. Post-hoc tests were run to identify which regions were significantly different from one another, see *Appendix I*. Any regions that were significantly different from one another, excluding NYCs, indicates that stratification by region rather than the SERA-defined groups (NYC and ROS), would improve the accuracy of the estimated number

of MTs in NY and their outflow from the state since this variation would be accounted for in the sample.

Table 6: Results of the Kruskal-Wallis H test for significant differences between NYS Regions for, average home age, average rooms per home, and average household income. See Appendix 1 for post-hoc analysis results.

Variable	***NYS Regions***	***NYC vs. ROS***
	p-value	
Average Home Age	*0.025*	*0.035*
Average Rooms per Home	*0.000*	*0.000*
Average Household Income	*0.000*	*0.201*

If the study was performed with stratification by region for businesses, single-, and multi-family homes the number of samples required to achieve 95% confidence with a +/- 5% margin of error would have increased the total number of samples required for the study five-fold (Tables 7 and 8). The larger sample size with a more even distribution throughout the state would therefore yield a more accurate estimate of MTs and their outflow from the state since the sample would have better accounted for the variation of these factors between regions.

Table: 7 : Number of residential housing units, number of responses needed to obtain 90% confidence with a +/- 10% margin of error, and number of responses needed to obtain 95% confidence with a +/- 5% margin of error per region

Region	**Census Housing Units[1]**		**Responses Needed for 90% confidence with +/-10% ME[2]**		**Responses Needed for 95% confidence with +/-5% ME[2]**	
	SF Homes	*MF Homes*	*SF Homes*	*MF Homes*	*SF Homes*	*MF Homes*
Capital District	327,641	159,973	68	68	384	384
Central NY	234,484	92,749	68	68	384	384
Finger Lakes	375,853	135,654	68	68	384	384
Hudson Valley	559,020	324,742	68	68	384	384
Long Island	850,377	180,812	68	68	384	384
Mohawk Valley	156,263	60,176	68	68	384	384

New York City	545,534	2,869,388	68	68	384	384
North Country	155,287	40,236	68	68	384	383
Southern Tier	200,501	74,160	68	68	384	384
Western NY	420,284	209,686	68	68	384	384
Total	***3,825,244***	***4,147,576***	***680***	***680***	***3,840***	***3,840***

***ME**: Margin of Error, **SF**: Single-Family, **MF**: Multi-Family*
1: Data Source: US Census, 2015B[12-14].
2: If the number of housing units was between two population sizes (Table 2), the larger of the two values was listed.

Table 8: Number of commercial business establishments, number of responses needed to obtain 90% confidence with a +/- 10% margin of error, and number of responses needed to obtain 95% confidence with a +/- 5% margin of error per region

Region	**Census Business Establishments[1]**		**Responses Needed for 90% confidence with +/-10% ME[2]**		**Responses Needed for 95% confidence with +/-5% ME[2]**	
	Sm Busn.	*M & L Busn.*	*Sm Busn.*	*M & L Busn.*	*Sm Busn.*	*M & L Busn.*
Capital District	43,360	37,421	68	68	384	384
Central NY	28,255	25,719	68	68	384	384
Finger Lakes	42,746	39,333	68	68	384	384
Hudson Valley	128,754	74,616	68	68	384	384
Long Island	186,150	103,737	68	68	384	384
Mohawk Valley	16,662	14,185	68	68	384	384
New York City	447,006	264,231	68	68	384	384
North Country	14,767	12,386	68	68	384	384
Southern Tier	20,737	19,344	68	68	384	384
Western NY	49,173	48,619	68	68	384	384
Total	***977,610***	***639,591***	***680***	***680***	***3,840***	***3,840***

***ME**: Margin of Error, **Sm**: Small, **M**: Medium, **L**: Large, **Busn.**: Business*
1: Data Source: US Census, 2015C[12-14].
2: If the number of business establishments was between two population sizes (Table 2), the larger of the two values was listed.

Non-Response Analysis

The results of the Kruskal-Wallis test showed that the average household income was significantly lower in counties without respondents from single- and multi-family household surveys (Tables 9 and 10). These results indicate that the number of MTs in New York homes estimated by SERA are likely overestimated than the actual total since homes with higher incomes are more likely to contain multiple thermostats. Similarly, SERA's estimated outflow of MTs from the state may be underestimated, meaning that the outflow is likely to occur faster (more MTs leaving the state earlier than estimated). However, the increase in the estimated number of thermostats would have likely been minimal since the non-response counties for single- and multi-family homes represent a small portion of the total number of housing units in the state (Table 4). The same can be said about the change in outflow if this method were applied. Although our proposed sampling method would have yielded more statistically accurate results, we believe the estimates provided by SERA are sufficiently accurate to use as a baseline to guide MT collections in New York State. All-in-all, these results reemphasize the importance of extending NY's MTCA to continue that state-wide requirement for proper MT collection and disposal.

Table 9: Results of the Kruskal-Wallis test for significant differences between counties with (response) and without single-family home responses (non-response) to the SERA survey for average household income and 5 year (2011-2015) average population

	Single-Family Homes				
		Response Group		***Non-Response Group[1]***	
Variable	*p-value*	*Median*	*n*	*Median*	*n*
Average Age of Home	*0.587*	*58*	*44*	*58*	*18*
Average Number of Rooms	*0.402*	*5.84*	*44*	*5.92*	*18*
Average Household Income	***0.000***	*$76,173*	*44*	*$60,667*	*18*
5 Year Average Population	***0.000***	*143,722*	*44*	*50,491*	*18*

(2011-2015)					
1: See Table A4 in Appendix 1 for the full list of counties without single-family home responses					

Table 10: Results of the Kruskal-Wallis test for significant differences between counties with (response) and without multi-family home responses (non-response) to the SERA survey for average household income and 5 year (2011-2015) average population

	Multi-Family Homes				
		Response Group		***Non-Response Group[1]***	
Variable	*p-value*	*Median*	*n*	*Median*	*n*
Average Age of Home	*0.733*	*58*	*44*	*58*	*18*
Average Number of Rooms	*0.457*	*5.84*	*44*	*5.91*	*18*
Average Household Income	***0.006***	*$69,815*	*44*	*$62,068*	*18*
5 Year Average Population (2011-2015)	***0.000***	*143,722*	*44*	*47,538*	*18*
1: See Table A4 in Appendix 1 for the full list of counties without multi-family home responses					

Mercury Thermostat Collections in New York State to Date

CSMM findings suggest that the SERA estimates are sufficient to guide mercury thermostat (MT) collection efforts in NYS, and therefore it is valid to compare the collection data provided by TRC to the SERA estimates. It was estimated that 4,180,000 MTs existed in NYS in 2015 (Table 11). Although this number may be slightly overestimated, it should still be used as the goal for MT collections in the state. SERA also estimated that between 2015 and 2024, 90,000 MTs would be removed from NYS buildings each year. However, since the NYS Mercury Thermostat Collection Act of 2013 was enacted, TRC recovered an average of 6,116 MTs per year. This indicates that up to 93% of mercury thermostats removed from buildings in NYS were not properly disposed of or were collected at HHW sites (Table 12). Although the rate of collections greatly increased by an average of 4,173 thermostat equivalents

collected per year, this increase only represents an improvement of 4.6% of the total estimated outflow of MTs each year (Table 12, Figures 2 and 3). Given that it is estimated 79% of MTs in the state are still to expire over the next 40 years, the best course of action would be to extend the NYS Mercury Thermostat Collection Act. Similarly, based on the relatively low level of collections to date, compared to the estimated annual outflow, it will be important to include additional provisions to the Act to reduce environmental degradation and reduce risks to human health.

Table 11: Estimated ten-year average annual outflows of mercury thermostats from New York Buildings

Year	Percent Recovered	Statewide flow
2015-2024	21%	90,000
2025-2034	53%	132,000
2035-2044	84%	127,000
2045-2054	98%	59,000
2055-2064	100%	10,000
	Total	*4,180,000*

Data was adapted from Figure 1 in the SERA report [7]

Table 12: Weight of mercury, total thermostat equivalents recovered, and estimated unrecovered mercury thermostats annually since the NYS Mercury Thermostat Collection Act of 2013 was passed (2013-2021)[7]

Year	Weight of Mercury Recovered[1] (lbs)	Unrecovered Weight of Mercury[2]	Thermostat Equivalents Collected	Unrecovered Mercury Thermostats[3]
2004	7.8	685.2	983*	89,017 *(98.9%)*
2005	8.7	684.3	1,095*	88,905 *(98.8%)*
2006	17.6	675.4	2,133*	87,867 *(97.6%)*
2007	10.0	683.0	1,350*	88,650 *(98.5%)*
2008	15.6	677.4	2,069*	87,931 *(97.7%)*
2009	19.3	673.7	2,566*	87,434 *(97.1%)*
2010	18.4	674.6	2,271*	87,729 *(97.5%)*
2011	20.2	672.8	2,454*	87,546 *(97.3%)*
2012	20.6	672.4	2,561*	87,439 *(97.2%)*
2013	16.4	676.6	1,942*	88,058 *(97.8%)*
2014	38.1	654.9	4,706*	85,294 *(94.8%)*

2015	75.6	617.4	11,890*	78,110 *(86.8%)*
2016	59.8	633.2	8,202*	81,798 *(90.9%)*
2017	81.2	611.8	8,133	81,867 *(91.0%)*
2018	49.0	644.0	6,947	83,053 *(92.3%)*
2019	37.5	655.5	4,845	85,155 *(94.6%)*
2020	29.6	663.4	4,285	85,715 *(95.2%)*
2021	33.2	659.8	4,094	85,906 *(95.5%)*
Pre-MTCA Average[4]	***15.36***	***677.6***	***1,943***	***88,057 (97.8%)***
Post-MTCA Average[5]	***46.72***	***646.3***	***6,116***	***83,884 (93.2%)***

1: TRC estimates that each mercury switch contains a minimum of 2.8 grams of mercury, with an average of 1.25 switches per thermostat in NY, each thermostat contains a minimum of 3.5 grams of mercury (or 0.0077 lbs).
*2: Unrecovered weight of mercury = weight of SERA estimated outflow - weight of mercury recovered. Weight of SERA estimated outflow = 90,000 MTs * 0.0077 lbs/MT = 693 lbs*
3: Unrecovered mercury thermostats = SERA Estimated Outflow - Thermostat Equivalents Recovered. We assume the outflow of MTs was the same prior to 2015 (90,000 per year).
4: Pre-MTCA = 2004-2012, the year before the MTCA was enacted; MTCA: (NYS) Mercury Thermostat Collection Act of 2013
5: Post-MTCA= 2013-2021, the years after the MTCA was enacted
**: Thermostat equivalents were estimated for years between 2004-2016 using the average conversion factor from 2017-2021 since the conversion factor was not provided during these years.*

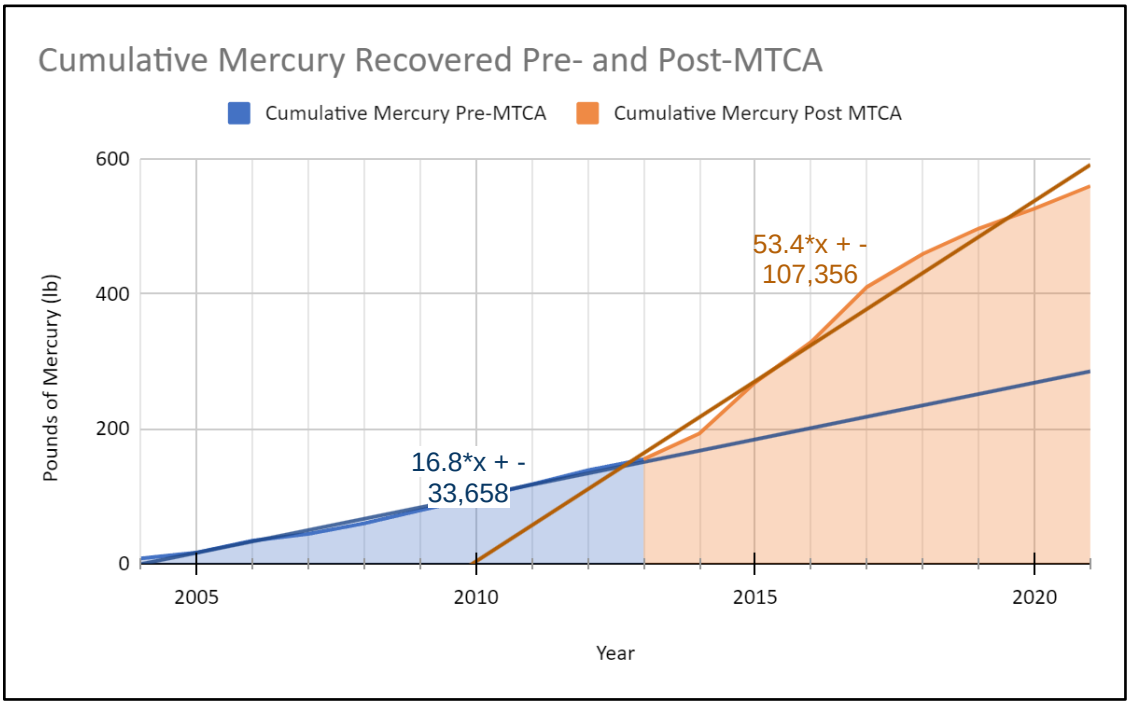

Figure 2: Total mercury recovered (lbs) over time in New York before and after the Mercury Thermostat Collection Act (Pre- and Post-MTCA, respectively). Data From SERA[7]

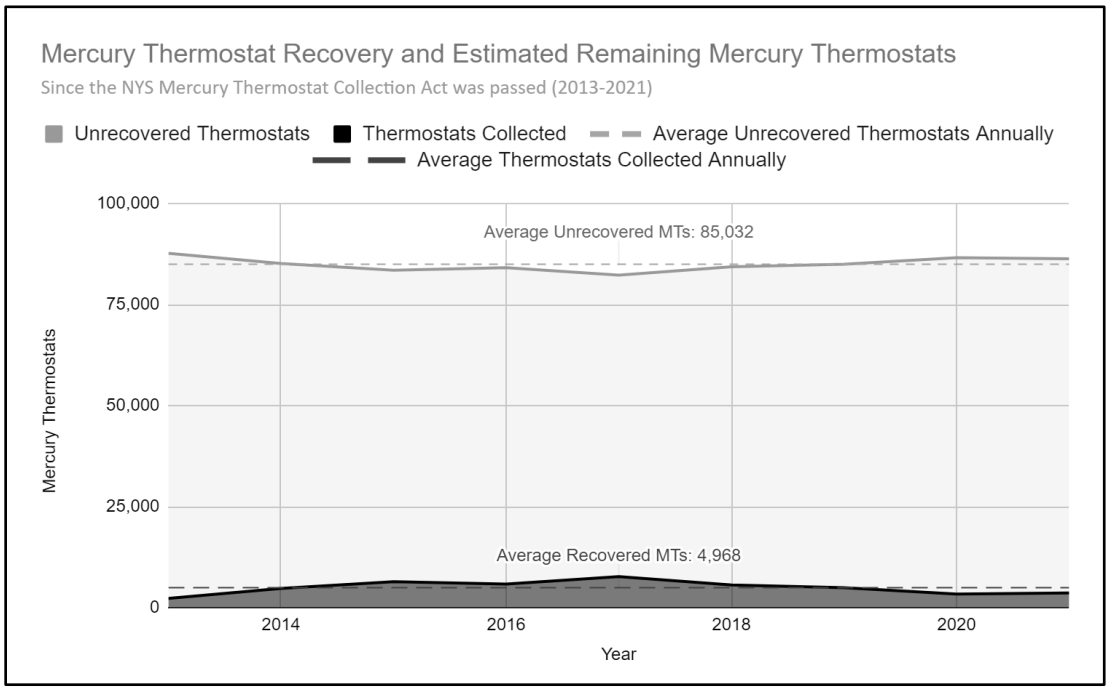

Figure 3: Mercury thermostats recovered compared to unrecovered mercury thermostats each year. Unrecovered thermostats were estimated using the estimated outflow for 2015-2024 from the SERA report.[7]

In the last five years of the program, there were an average of 149 MT collection sites across the state of New York that consistently returned bins. This equates to about 1 site per 132,000 residents and about 1 site every 316 square miles. However, distribution of sites is uneven between different regions of the state. For example, the distribution of sites ranges from 1 site per 573,000 residents (New York City) to 1 site per 50,000 residents (Central New York). Alternatively, the distribution of sites per square miles (land area) ranges from 1 site per 20 sq mi (New York City), to 1 site per 2,036 (North Country) (Table 13). This indicates that there is a much higher density of sites in highly populated areas. While this information points to underserved areas - low site to land area ratio and higher site to population ratio, it is important that we identify areas in the state that are completely unserved.

Table 13: Five year average regional population, land area, total collection sites, population per site, and land area per site in New York State (2017-2021)[12-14]

	5 Year Average (2017-2021)				
Region	**Population**	**Land Area** (sq mi)	**Sites**	**Pop/Site**	**Area**(sq mi)**/Site**

Capital District	1,092,179	5,170	16.6	65,794	311
Central NY	777,699	3,575	15.6	49,852	229
Finger Lakes	1,209,310	4,676	20.8	58,140	225
Hudson Valley	2,352,436	4,534	20.2	116,457	224
Long Island	2,869,574	1,197	22.4	128,106	53
Mohawk Valley	483,561	5,146	5.4	89,548	953
New York City	8,480,973	303	14.8	573,039	20
North Country	419,489	11,402	5.6	74,909	2,036
Southern Tier	634,173	6,161	9.4	67,465	655
Western NY	1,393,471	4,963	18.2	76,564	273
New York State	***19,712,866***	***47,126***	***149***	***132,301***	***316***

Over the five year period (2017-2021), there were 24 counties that had less than one collection site on average. Although these counties only represent about 6% of the total population, they represent about 71% of the rural counties in the state (micropolitan and noncore populations). Rural communities are an important demographic to address when implementing programs that pose risks to human health and the environment. Not only will the implementation of these programs function differently than in urban areas, but rural communities often feel overlooked during the implementation of state legislation.[18]

Table 14: Regions with counties with less than 1 site over the 5 year average (2017-2021), with the population and land area of those counties and their proportion of the state

Region	*5 Year Average (2017-2021)*		
	Counties with less than 1 site with urbanization[19]	**Population** (% of state)	**Land Area in Square Miles** (% of state)
Capital District	**Small Metro**: Washington **Noncore**: Greene	108,907 (0.55%)	1,478 (3.14%)
Central NY	**Micropolitan:** Cortland	47,230 (0.24%)	499 (1.06%)
Finger Lakes	**Large Fringe Metro**: Livingston, Orleans, Wayne, Yates **Micropolitan**: Seneca **Noncore**: Wyoming	292,554 (1.48%)	2,881 (6.11%)

Hudson Valley	**Noncore**: Sullivan	76,854 (0.39%)	968 (2.05%)
Long Island	--	--	--
Mohawk Valley	**Medium Metro**: Schoharie **Micropolitan**: Fulton, Montgomery, Otsego	192,509 (0.98%)	2,522 (5.35%)
New York City	--	--	--
North Country	**Micropolitan**: Franklin **Noncore**: Essex, Hamilton, Lewis	117,605 (0.60%)	6,415 (13.61%)
Southern Tier	**Small Metro**: Tioga **Micropolitan**: Steuben **Noncore**: Chenango, Delaware, Schuyler	252,606 (1.28%)	4,573 (9.70%)
Western NY	**Noncore**: Allegany	46,308 (0.23%)	1,029 (2.18%)
	Total	1,134,574 (5.76%)	20,367 (43.2%)

Over the past five years, collection sites in NYS largely consisted of wholesaler locations and private contractors, 79.4% and 15.3% respectively (Figure 4). Customers of construction and building material wholesalers are typically contractors, developers, and construction companies, so it is unlikely for the average homeowner to visit these locations. While some MTs from private homes will be managed by contractors or other building companies, many do-it-yourself (DIY) homeowners will replace the MTs in their homes themselves. These homeowners may be unaware of the appropriate disposal procedure or that a collection site is nearby due to inadequate advertising and outreach. While wholesaler locations were the most abundant, contractors had the highest ratio of mercury collected per “site”.

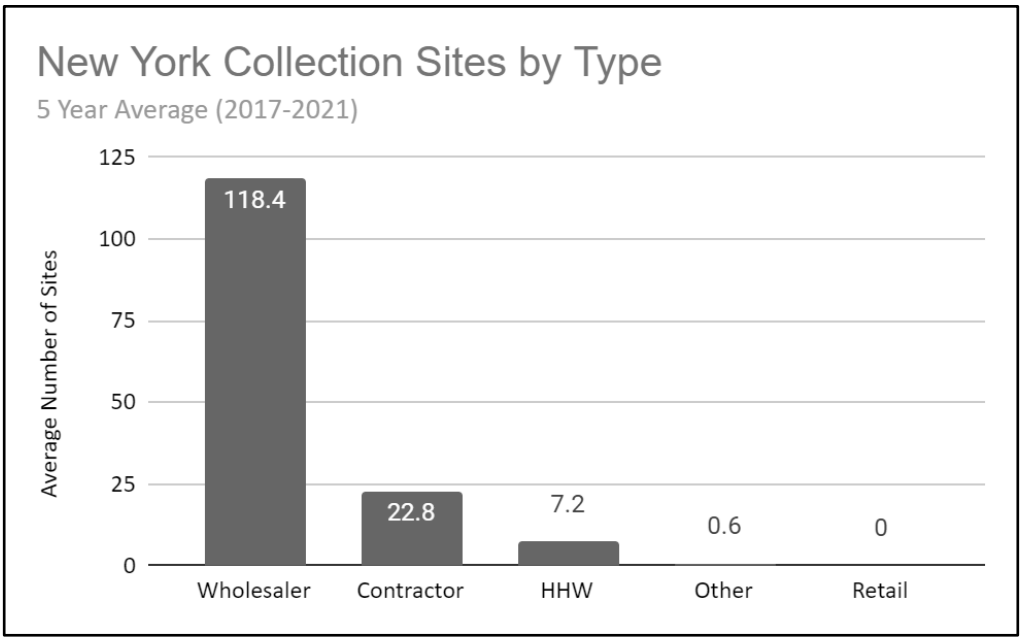

Figure 4: Five-year average of New York State collection sites by site type (2017-2021) ***TRC***

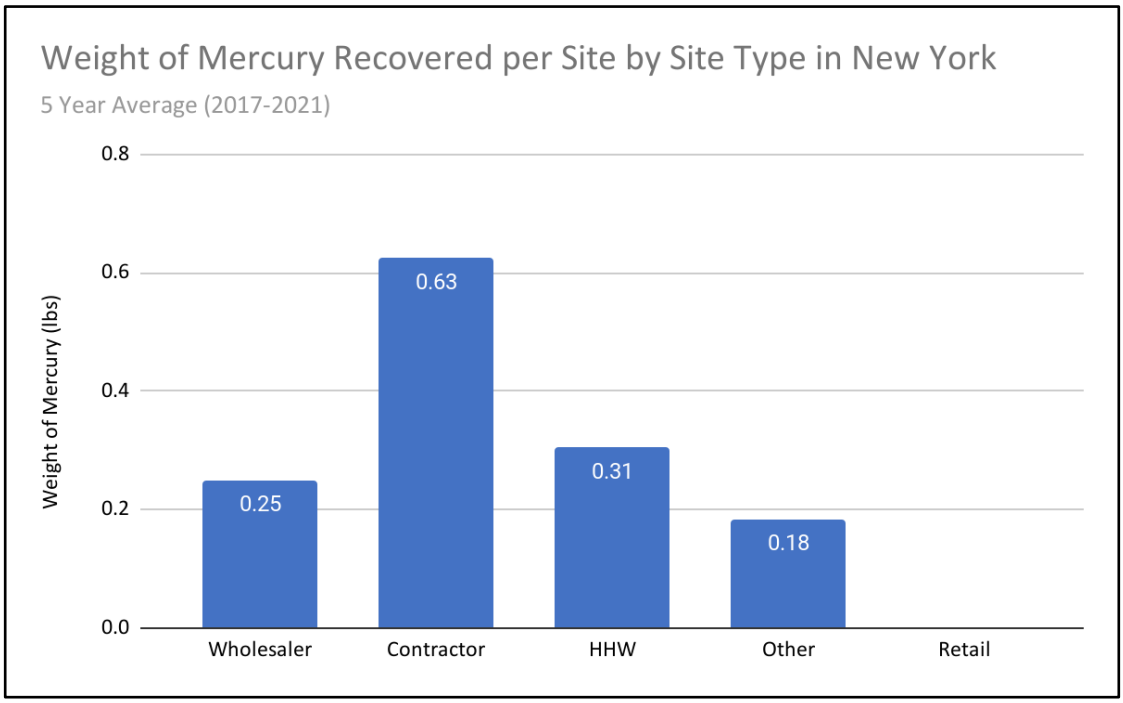

Figure 5: Average weight of mercury recovered from mercury thermostats per site by site type in New York State between 2017-2021

CSMM's benchmarking determined that a program's success greatly depends on provisions built into legislation. Contributing factors that impact the success of extended producer responsibility legislation include but are not limited to, mandated financial incentives, site convenience measures, education and outreach programs, and engagement between producer

responsibility organizations (PROs) and state Departments. The current application of these practices in NYS are outlined in Table 15. Similar tables for high-performing states are included in Section 2 of this report.

Table 15: Summary of contributing factors for the New York State Mercury Thermostat Collection Act of 2013

Contributing factors	**2013 New York State Mercury Thermostat Act requirements**
Convenience	● Wholesale supply stores that sell thermostats are required to become a TRC drop off site ● Retail stores and local sites may volunteer to be TRC drop off sites ● TRC will offer collection bins to potential collection sites for free. There is no charge unless the bin is lost or damaged.
Outreach, Education, and Reporting	● TRC must provide a report each year with: ○ The financial breakdown of their expenses ○ The number of out-of-service thermostats collected ○ A description of outreach and education strategies ● TRC must maintain a website with: ○ A collection site locator tool ○ Access to state reports ○ Access to sharable educational materials ● Contact wholesalers sites once a year ● Release articles for targeted contractor audiences ● Provide collection sites with printed materials and signage
Financial Incentive	● No incentive
Supporting Policies	● Landfill Ban: No landfill operator or transporter may willingly put a out of service mercury thermostats ● Manufacturers can only sell thermostats if they a registered with TRC ● Retailers and wholesalers may not sell thermostats from manufacturers that do not participate in the program ● Any person who removes an out- of-service mercury thermostat must deliver that thermostat to a collection site
Department Tasks	● Set collection goals for TRC for 2016-2023 ○ *These goals were not set* ● Author a report analyzing the thermostat program and provide recommendations if the program is not reaching the intended goals ○ Before setting collection goals the department must consult with environmental groups and thermostat manufacturer representatives ○ *This report was not performed* ● Maintain a website with: ○ A description of collection programs

	○ The report to the Governor ○ A list of collection sites
Stats	● Rank-32nd: 0.246 *lbs$_{Hg}$/100,000 residents* ● Population: 19,835,913 *residents*

Note: The items outlined in this table are the responsibility of the PRO, the Thermostat Recycling Corporation except for the items identified as Department tasks. [20]

Task 1 Summary

CSMM's recommended sampling approach would have yielded a more accurate estimate of the number of MTs and their outflow from the state than the SERA study, but would have likely yielded similar results, if these parameters (age of home, number of rooms or size of home, and household income) are the only variables to impact these estimates. This conclusion can inform the State's next steps in one of two ways: 1) an additional study could be performed to verify the results of the SERA study, or 2) acceptance of the SERA results and continue to use these estimates as the benchmark for mercury thermostat recovery goals. CSMM recommends the latter- although the sampling methods could have been improved, it is likely that the estimates are not greatly different from the true number of MTs and their outflow from the state.

The NYS program has collected more mercury thermostats after passing the NYC MTCA in 2013. Since then, the collections have not improved but plateaued. The majority of drop sites are wholesale locations, indicating there is a lack of site type diversity. The spatial and per capita distribution of collection sites is poor; some counties do not have a single site. CSMM's results will re-emphasize the importance of adopting a more effective mercury thermostat collection program and outline the opportunities that exist that will lead to a significant increas in collection rates.

Task 2. Assess impacts of supporting factors on mercury thermostat collection in other states

Methods

The performance of a mercury thermostat program varies widely based on the contributing factors supporting it. Contributing factors are outreach and education, convenience of drop off sites, financial incentive, supporting laws such as landfill bans, and collection goals.[21]

To better understand this interaction, CSMM contacted state departments to determine how their programs functioned and to learn the challenges of their programs (Appendices II and III). CSMM conducted interviews with representatives from California, Maine, Vermont, Rhode Island, Minnesota,

Iowa, Florida, Massachusetts, and Illinois. CSMM also received program information from the Product Stewardship Institute (PSI) and TRC. See Tables 4-7, which highlight the different State programs.

State recycling performance was characterized by average pounds of mercury per 100,000 people, per year, from 2016-2021. This data was collected from TRC's website and census data were used for state populations. Pounds per mercury was used as a metric because TRC collects both loose mercury switches in addition to regular thermostats. A five (5) year average from 2016-2021 was used to better reflect the recent trends in thermostat recycling.

Results

Vermont

Vermont's mercury thermostat program started in 2008 and recently and historically receives a strong program ranking; it is first in pounds of mercury collected per capita. Vermont is the smallest state interviewed, with 645,570 individuals according to 2021 data. Vermont's Department of Environmental Conservation is actively engaged in every aspect of their program collaborating with TRC and providing important feedback. The culture of Vermont's Department can be described as connected and self-sufficient. Vermont also is home to more local hardware stores rather than large, corporate chains. These local stores tend to be more invested and engaged into the community, which made advertising and managing the program easier for the Department. According to the Vermont department, residents, municipalities and local stores were more likely than other entities to take action and address the problem of mercury collection in their community. Highlights of Vermont's program include, Joint EPR Advertising, goals for site visits rather than number of thermostats, distribution of educational materials when a thermostat is purchased, collaboration on site visits and a successful incentive pilot program (Table 16,Appendices II and III-a)[22].

Table 16: Summary of contributing factors for the Vermont Mercury Thermostat Recycling Bill of 2008

Vermont Contributing factors	**Vermont 2008 Thermostat recycling bill**
Convenience	• Wholesale supply stores that sell thermostats are required to become a TRC drop off site • Retail stores and municipal sites may volunteer to be TRC drop off sites • TRC will offer collection bins to potential collection sites for $25 • Contractors may request a bin from TRC

Outreach, Education, and Reporting	• TRC must provide a report each year with:
	  ○ The financial breakdown of their expenses
	  ○ The number of out of service thermostats collected
	  ○ A description of outreach and education strategies
	• TRC must maintain a website with:
	  ○ A collection site locator tool
	  ○ Access to state reports
	  ○ Access to sharable educational materials
	• Visit sites every other year and call them on the off year
	• Release articles for targeted contractor audiences
	• Provide collection sites with printed materials and signage

Financial Incentive	• $5 incentive per thermostat
	  ○ At wholesale and municipal sites, the incentive is mailed to the individual by TRC at a later date
	  ○ At retail sites the incentive is an in-store coupon
	  ○ No limit to amount that can be returned

Supporting Policies	• Landfill Ban: No landfill operator or transporter may willingly put an out of service mercury thermostats • Manufacturers can only sell thermostats if they are registered with TRC • Retailers and wholesalers may not sell thermostats from manufacturers that do not participate in the program • Retailers must distribute educational materials when selling thermostats • Selling ban of Mercury Thermostats

Department Tasks	• Submit a report to the legislation regarding the effectiveness of the program if the program is not performing well
	• Collection goals were not set
	  ○ Instead, Vermont made site visit goals for TRC, to visit each site every other year and call on the off year.
	
	Additional activities:
	• Conducted site visits to participating sites with TRC
	• Coordination between TRC and Department
	• Provided feedback for revision of TRC advertising methods.
	• Advertised extensively to the Vermont community about the program separately from what TRC was doing
	• Created joint advertisements for all Vermont EPR programs
	  ○ Each PRO or government program pays a fee for the department to do make a joint advertisement
	  ○ All links to EPR programs are in one spot on department webpage
	  ● Includes a toll free question line
	  ○ Advertisements were in multiple languages

Stats	• Rank 1st: 2.216 *lbs/100,000 residents* • Population: 645,570 residents

Note: The items outlined in this table are the responsibility of the PRO, the Thermostat Recycling Corporation except for the items identified as Department tasks.

Maine

Maine's Program has similar results to Vermont's program. The Program began in 2006, has a population of 1,372,247 and ranks 3rd in collection with a rate of 1.861 lbs/100000ppl. The state conducts direct engagement by conducting regular meetings with TRC and key stakeholders. The small community culture and population, similar to that of Vermont's, allows for an easier collection process with regard to their outreach and enforcement perspective. Maine program highlights include contractor thermostat reports and a financial incentive program (Table 17,Appendices II and III-b).[23]

Table 17: Summary of contributing factors for the Maine Thermostat Recycling Bill of 2006

Contributing factors	**Maine 2006 Thermostat recycling bill**
Convenience	• Wholesale supply stores that sell thermostats are required to become a TRC drop off site • Retail stores and municipal sites may volunteer to be TRC drop off sites • TRC will offer collection bins to potential collection sites for $25

Outreach, Education, and Reporting	• TRC must provide a report each year with:
	  ○ The financial breakdown of their expenses
	  ○ The number of out of service thermostats collected
	  ○ A description of outreach and education strategies
	• TRC must maintain a website with
	  ○ A collection site locator tool
	  ○ Access to state reports
	  ○ Access to sharable educational materials
	• Contact wholesaler sites once a year
	• Release articles for targeted contractor audiences
	• Provide collection sites with printed materials and signage

Financial Incentive	• $5 incentive per thermostat
	  ○ At wholesale and municipal sites, the incentive is mailed to the individual by TRC at a later date
	  ○ At retail sites the incentive is an in-store coupon
	  ○ No limit to amount that can be returned

Supporting Policies	• Landfill Ban: No landfill operator or transporter may willingly put a out of service mercury thermostats • Manufactures can only sell thermostats if they are registered with TRC • Retailers and wholesalers may not sell thermostats from manufactures that do not participate in the program • Any person who removes an out of service mercury thermostat must deliver that thermostat to a collection site • Selling ban of Mercury Thermostats • Contractors must submit a yearly report regarding mercury thermostat removal ○ Includes number and location of thermostats collected
Department Tasks	• Submit a report to the legislation regarding the effectiveness of the program annually

	• Set collection goals Additional activities: • Conducted site visits to participating sites with TRC ○ Coordination between TRC and DEP to maximize the number of sites covered each year • Provided feedback for revision of TRC advertising methods. • Semi regular meetings between TRC, Department and stakeholders
Stats	• Rank 3rd: 1.861 *lbs/100,000 residents* • Population: 1,372,247 *residents*

Note: The items outlined in this table are the responsibility of the PRO, the Thermostat Recycling Corporation except for the items identified as Department tasks.

California

The effectiveness of California's 2021 Thermostat Recycling act is undetermined as certain aspects of the law are currently not set up or will require more time to understand. In review of California's 2008 Thermostat Recycling Act and in discussion with key stakeholders, it is clear that there are areas of opportunity for this legislation; California is ranked 23rd with a rate of 0.403 lbs/100000ppl.

California is a large state with a population of 39,237,836 people. It is also quite diverse with rural, urban and suburban populations as well as being physically vast. This makes developing an effective thermostat recycling program extremely difficult as large diverse populations require more effort to reach out to and enforce. Collection recovery data after enactment of their 2008 law was weaker than expected, and in 2021 California updated its laws to include much stronger provisions. California believes TRC has a conflict of interest by providing a financial incentive and being responsible for advertising the program so the California law allows for a third party to run the advertising program using TRC's finances. Other highlights include developing specific and direct outreach targets, introducing a $30 financial incentive per thermostat, an annual budget for outreach, definition of site location convenience and a requirement for TRC to provide funding to the Department for enforcement(Table 18, Appendices II and III-a).[24]

Table 18: Summary of contributing factors for the California Mercury Thermostat Collection Act of 2021

Contributing factors	**California Mercury Collection Act of 2021**
Convenience	• Wholesale supply stores that sell thermostats are required to become a TRC drop off site • Retail stores and municipal sites may volunteer to be TRC drop off sites • TRC will offer collection bins to potential collection sites at no cost unless lost or damaged. • There must be a collection site in each county and a site within 15 miles of 90% of

	residents
Outreach, Education, and Reporting	● 3rd party must provide a report each year with ○ The financial breakdown of their expenses ○ The number of out of service thermostats collected ○ A description of outreach and education strategies ● 3rd party must maintain a website with ○ A collection site locator tool ○ Access to state reports ○ Access to sharable educational materials ● Outreach tools ○ Release articles for targeted contractor audiences ○ Provide collection sites with printed materials and signage ○ Make a PSA regarding thermostat recycling A 3rd party will be responsible for developing and providing outreach and education ● Manufacturers must pay the 3rd party $2 million the first year then decreasing amounts each year after. ● This outreach must target Contractors State License Board, HVAC contractors, retailers, demolition, municipalities, HHW, property management associations, homeowners, rural districts, disadvantaged communities and general public ● The 3rd party developing outreach and education will likely not be TRC as their is a conflict of interest in developing outreach and providing incentives
Financial Incentive	● $30 incentive per thermostat ○ At all sites the incentive will be provided in the form of a check received at a later date from TRC. ○ Proof of California residency must be provided ○ No limit to amount that can be returned
Supporting Policies	● Landfill Ban: No landfill operator or transporter may willingly put a out of service mercury thermostats ● Manufactures can only sell thermostats if they are registered with TRC ● Retailers and wholesalers may not sell thermostats from manufactures that do not participate in the program ● All new thermostats sold must come with mercury thermostat educational materials ● Selling ban of Mercury Thermostats ● Manufacturers shall pay the department an aggregate of $400,000 each year to manage the enforcement of this policy
Department Tasks	● Submit a report to the legislation regarding the effectiveness of the program prior to 2028 ● Set collection goals ● Enforce the program using the $400,000 provided yearly by manufactures ● Approve or revise all plans provided by 3rd parties to manage the program Additional activities ● To be determined as 2021 law has more time to go into effect

Stats	• Rank: **To be determined as 2021 Law has time to go into effect** • Population: 39,237,836 ppl

Note: The items outlined in this table are the responsibility of the PRO, the Thermostat Recycling Corporation except for the items identified as Department tasks.

Iowa

Iowa's program had performed moderately well, ranking 14th with a rate of 0.601 lb/100,000ppl. Iowa has a medium sized population of 3,193,079 ppl. Overall, Iowa maintained an average program with fairly low Department involvement. In 2021. Iowa's Mercury thermostat bill sunset. Since then, the only programmatic changes were the development of TRC reports and the removal of the Department position managing thermostat recycling. Collection rates have stayed relatively the same despite these changes (Table 19).

Table 19: Summary of contributing factors for the Iowa Mercury Thermostat Collection Act of 2009

Contributing factors	**Iowa Mercury thermostat act 2009**
Convenience	• Wholesale supply stores that sell thermostats are required to become a TRC drop off site • Retail stores and local sites may volunteer to be TRC drop off sites • TRC will offer collection bins to potential collection sites unless the bin is lost or damaged

Outreach, Education, and Reporting	• TRC must provide a report each year with:
	  ○ The Financialbreakdown of their expenses
	  ○ The number of out of service thermostats collected
	  ○ A description of outreach and education strategies
	• TRC must maintain a website with:
	  ○ A collection site locator tool
	  ○ Access to state reports
	  ○ Access to sharable educational materials
	• Contact wholesaler sites once a year
	• Release articles for targeted contractor audiences
	• Provide collection sites with printed materials and signage
	• Retail sites selling thermostats must advertise the program

Financial Incentive	• No incentive
Supporting Policies	• Landfill Ban: No landfill operator or transporter may willingly put a out of service mercury thermostats • Manufacturers can only sell thermostats if they are registered with TRC • Retailers and wholesalers may not sell thermostats from manufacturers that do not participate in the program • Any person who removes an out of service mercury thermostat must deliver that thermostat to a collection site

Department Tasks	• Set collection goals for TRC • Establish a process for program review • Establish a process to set goals and if goals are not met review • Approve of manufacturer plans
Stats	• Rank-14th: 0.601 *lbs/100,000 residents* • Population: 3,193,079 *residents*

Note: The items outlined in this table are the responsibility of the PRO, the Thermostat Recycling Corporation except for the items identified as Department tasks.

Based on these programs, CSMM concludes that Vermont and Maine performed significantly better than other states because these states both have incentives, convenient and accessible collection sites, and significant outreach efforts. Most importantly, these programs actively work with TRC and the Department to address the specific needs of that state. On average, CSMM determined that voluntary state programs collect less mercury thermostats than mandatory programs (Figure 6).

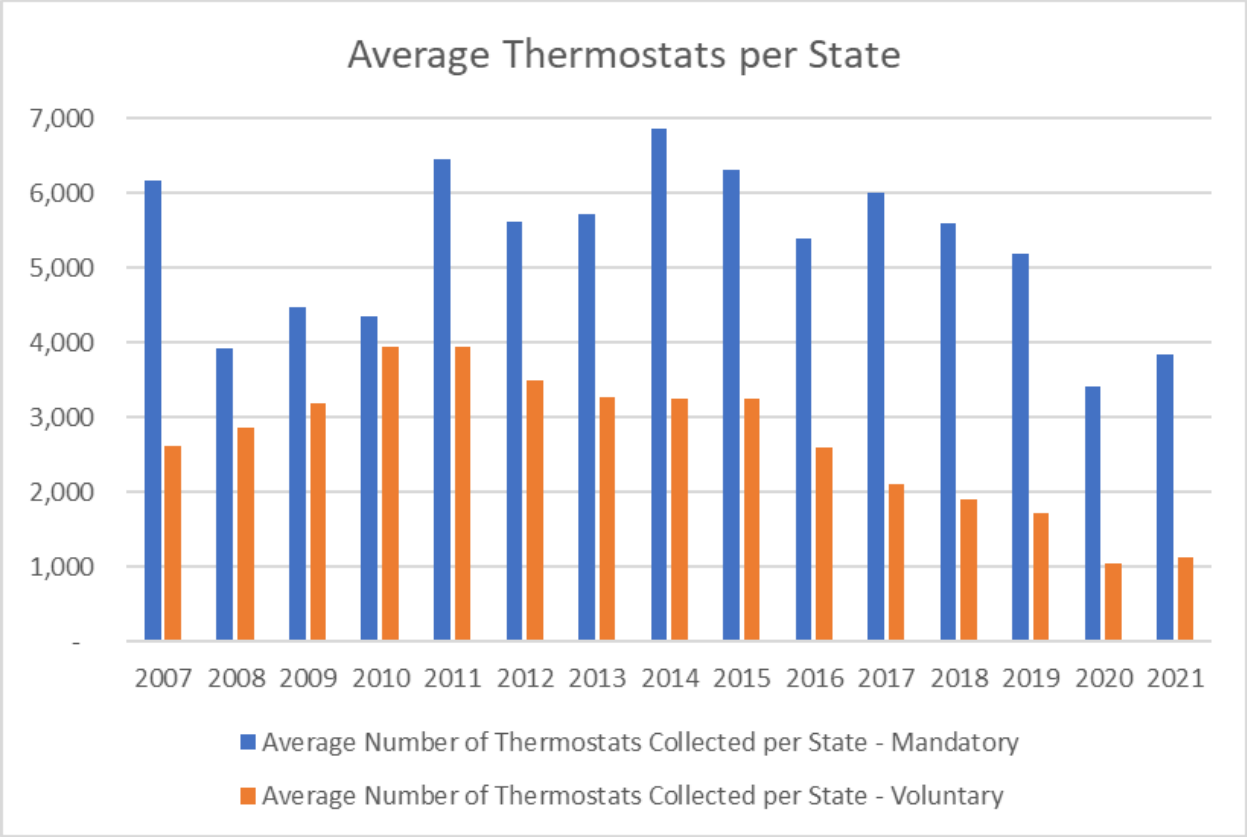

Figure 6: The average number of thermostats collected per year in states with mandatory and voluntary programs. Thermostat data is based on TRC reporting. This chart was created by the Maine Department of Environmental Protection(appendix 3b).

However, outliers to this do exist. States like North Dakota, Nebraska, South Dakota, Wisconsin, Maryland and Oregon perform better than New York, Illinois, and California which don't

make the top 15 despite having mandatory programs. These states have small to medium populations that are easier to engage with, while New York, California and Illinois have large diverse populations.

This suggests two things, 1) current mercury thermostat collection programs are weak, and 2) state demographics can be a significant barrier to developing a successful program. The populations within the United States are quite diverse , even within a state. Successful program management requires knowledgeable and engaged staff who understand the culture of, and are connected to, that particular state. Based on CSMM findings, successful programming also requires conducting site visits, educating residents, developing and distributing advertisements and providing TRC regular, local feedback on how to optimize their programs.

Summary

Other states have had varied success but the most successful ones have active communication between TRC and the Department. State demographic diversity is the biggest barrier to a program's success. The best way to overcome this barrier is to have either TRC or DEC staff dedicated to understanding the culture and recycling behavior of their state and making connections to it.

Task 3. CSMM Recommendations

Methods

CSMM collected extensive data from TRC, SERA, PSI and other State programs to develop and validate our recommendations. To develop the recommendation for site convenience, the density of sites per land area were calculated for the Illinois and Vermont retail pilot programs. This was completed to demonstrate the importance of site distribution. CSMM collected both the number of collection sites per county and the weight of mercury collected per site from 2017 to 2021 for Vermont, Maine, and New York from TRC. CSMM calculated the average number of collection sites over the last five years. It is important to note that the number of sites on TRC's website is much larger for each state because many sites are counted as active but have not returned a bin this year. The TRC site data was used to calculate the historical site densities of each state, to demonstrate the differences in site convenience.

Using Vermont and Maine as an example, CSMM conducted an analysis to compare the relationship between the number of sites in a county and its collection rates. This was done by taking the five year average of the number of sites in a given county and plotting it against the five year average of collection rates in a given county. The 2021 Data from TRC on the distribution of collection by site type was reformatted to a bar graph for Maine and Vermont.

The recommendations regarding education and outreach were made based on anecdotal evidence from other states and where gaps in collection and recycling exist.

The financial incentive recommendations were chosen by analyzing the collection history of Maine and Vermont's programs before and after a financial incentive. The Indiana and Oregon incentive pilot programs were used to analyze the effect of other supporting factors on incentive performance.[26]

Task 3 Summary: Recommendations

Extend the Mercury Thermostat Act to at least 2045

The last stock of mercury thermostats were taken out of stock in 2015. With an expected useful life of 30-50 years, improper disposal of mercury thermostats is a continuing threat to individual health and our environment that needs to be addressed by a legislative amendment. SERA reports estimate that because of the amount and decay rate of mercury thermostats they will continue to come off the walls until 2060. Based on Figure's 2 and 3, TRC is only capturing 7% of thermostats coming off the walls annually. This equates to 693 pounds of mercury being improperly disposed of or is recovered at HHW sites. SERA estimates the number of thermostats expiring will be 130,000 annually from 2025 to 2045. CSMM's recommendation is that the current Mercury Thermostat Collection Act be extended to 2045. As seen in the SERA chart, 84% of the thermostats will have expired through the system by 2044. To extend the MTCA after 2045, CSMM recommends that the State assess the existing landscape and the productivity of the program to determine if extending the MTCA is economically feasible. CSMM also recommends that if the law is extended, proposed legislation would continue to maintain a requirement for TRC to provide a yearly report to DEC, and would require the Department to perform an assessment of the program every five years.

Fully Fund the Mercury Thermostat Collection Program

The current thermostat program in NYS has not yet reached its collection goals. In order to enhance and oversee the programmatic needs of this program, the efforts of the DEC and TRC will need to be fully funded by thermostat manufacturers. CSMM recommends NYS increase the resources allocated to this program to both increase staff time from the Department and allow TRC more resources for direct collection.

The Department's Product Stewardship Section is small with only three staff members to oversee the many extended producer responsibility (EPR) programs in NYS. Current and emerging NYS EPR legislation has increased the responsibilities for the Product Stewardship Section without the needed resources to accomplish those tasks. As it stands for the current mercury thermostat bill, and the modifications we will suggest below, the product stewardship team requires more staff and funding to deliver an impactful thermostat program.

CSMM suggests that MT collection goals for NYS should be made prior to the year they are implemented. The use of the SERA report MT numbers is valid to use when setting goals. CSMM recognizes that the collection number reported by TRC does not reflect all mercury thermostats

recovered from NYS since many were likely recovered collectively as universal mercury waste at household hazardous waste collection locations. CSMMs recommends that the Department consider all sources of mercury thermostat recovery in the state, measured or not, when setting future collection goals. As seen in Vermont, it may be helpful to set goals for convenience and outreach rather than rely on thermostat collection goals as measures of success. However, collection goals do not necessarily need to align with the SERA estimates since we know a portion of MTs are recovered, but not counted by TRC, at HHW facilities.

The Thermostat Recycling Corporation (TRC) requires more funding from its manufacturers to support its operations in order to deliver a successful program. TRC does not have any full-time staff members. In 2021, TRC spent $18,191 on advertising in NYS[6]. All mercury thermostat collection work is contracted to the Kellan company, a company that provides personnel assistance to nonprofits. The two staff members from Kellen company primarily responsible for the TRC national program are TRC's Executive Director and Operations & Compliance Manager. All TRC site visits are contracted out to the Center for EcoTechnology (CET). Currently, CET employs one person to conduct site visits on a needs-only basis for the entire Northeast region (appendix III-d). To run a national program effectively this is not enough staff. It is important to note that actions such as thermostat incentives and effective advertising, are conflicts of interest for TRC because they raise the cost of running the program.

Based on CSMM's review, it is clear TRC and DEC require additional staff to effectively manage this program and meet the goals of increased MT collection. Specific increased resource allocations should be outlined in a required plan that TRC submits to the DEC for approval. Resources to fund this effort will be collected from the manufacturers through TRC.

Increase Site Diversity and Convenience for Collection

CSMM has determined that site diversity and convenience are critical to the success of MT collection program performance. For example, a comparison between Illinois and Vermont's MT programs shows how these factors are important. In a one year period, the Illinois pilot collected 218 thermostats while the Vermont program collected more in less time – 1,200 thermostats in just two months. Additionally, during the pilot, Vermont had a retail site density of 10 sites per 1,000 square miles (sq mi) while Illinois had a density of .9 retail sites per 1,000 sq mi. It should also be noted Vermont had stronger community outreach and education. Higher site density and stronger communication and outreach have contributed to Vermont's higher collection rate. California's 2021 act defines site convenience as a site within each county and 90% of the population being at most 15 miles from a site.[26-27]

In NYS there have been an average of 148 sites in the state over the last five years, which is a density of 2.7 sites per 1,000 sq mi. In Vermont, the average density for the past five years is 8.4 sites per 1,000 sq mi. NYS lacks the site density it needs to be a successful program. Although this measure does not consider site density relative to population centers, it is still a good indicator for the number of sites needed in a state to optimize MT collection. The other trend that can be seen in Vermont and Maine is that counties with more sites have positive relationships with higher thermostat collection results (Figure 7). By using the 5-year average number of sites and pounds of mercury collected per

county, yearly variation is accounted for and therefore demonstrate the trend over time. Successful states like Maine and Vermont have higher site densities, which ultimately yields higher collection rates.

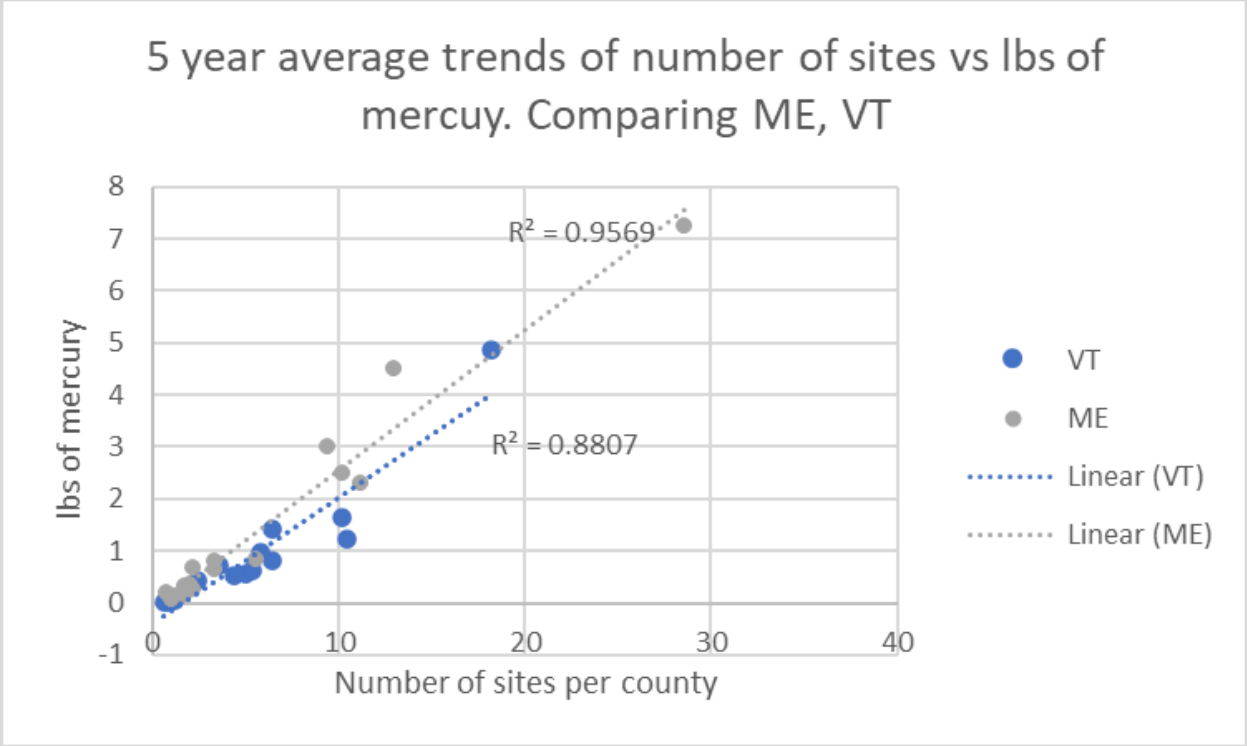

Figure 7: Sites per county vs pounds of mercury recovered in Maine and Vermont over a 5 year average (2017-2021). Data source: Thermostat Recycling Corporation[19]

Another factor to consider is that certain sites attract different populations. The most common collection site types include retail stores, wholesale stores, local municipal sites (like household hazardous waste facilities or HHWs), and contractors with their own bins. There are two types of consumers who drop off thermostats – contractors and DIY homeowners. Homeowners are more likely to drop off at retail sites where they normally shop, while contractors are more likely to drop off at wholesale locations. In the Illinois retail pilot program, 26 of the 30 survey respondents were homeowners rather than contractors. Local municipal or HHW sites are also approachable to homeowners[27]. Maine's program is an excellent example of optimized site diversity. Compared to New York, there is a more even distribution between retail and wholesale sites and there are no retail sites in NY (Figures 8 and 9).

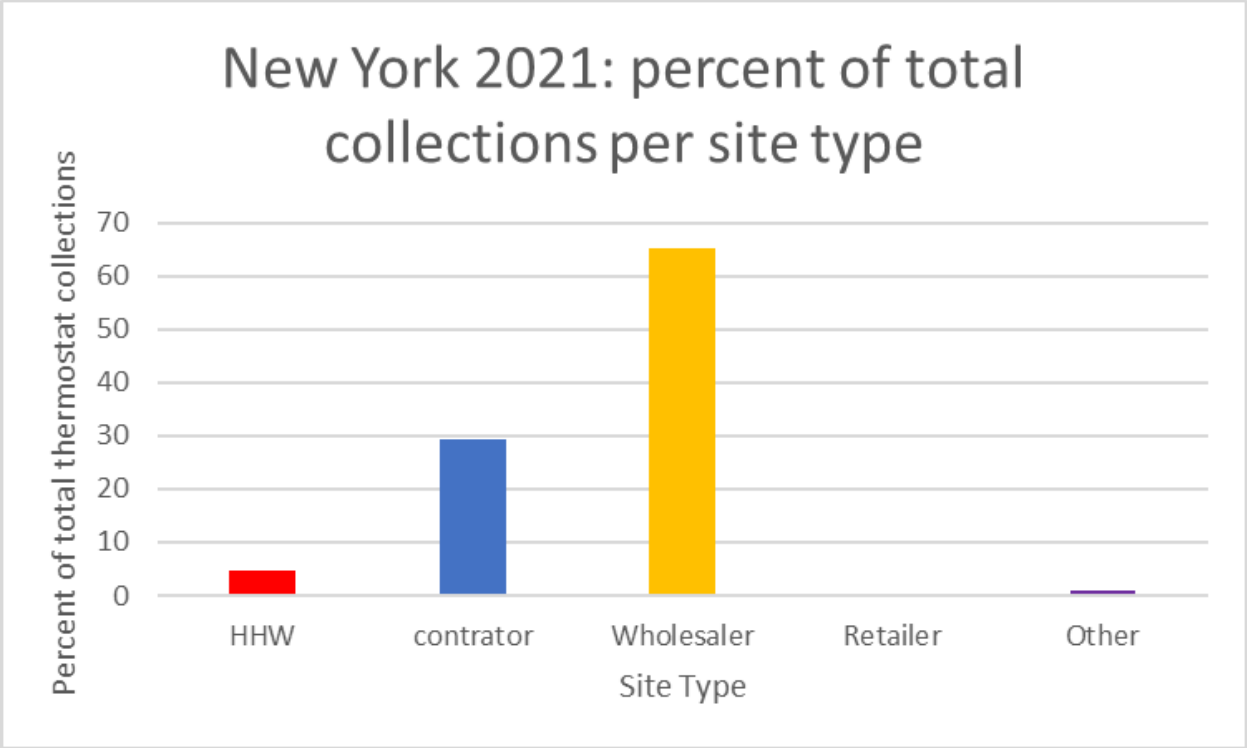

Figure 8: Percent of the total thermostats collected by each site type in New York 2021.[8]

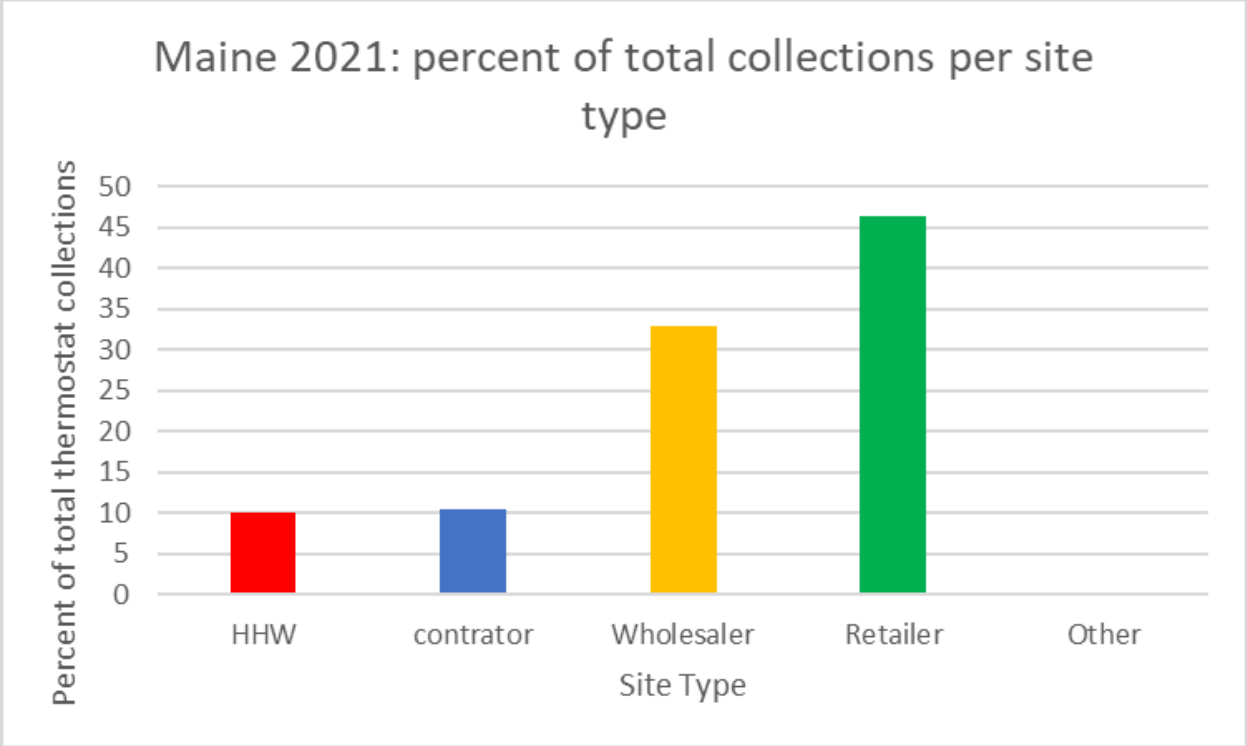

Figure 9: Percent of the total thermostats collected by each site type in Maine 2021.[8]

Because NYS is lacking in terms of both site density and diversity we recommend the following legislative amendments:

1. Municipal and commercial recycling locations that collect mercury-containing materials under universal waste laws should be required to separate mercury thermostats into TRC bins (this includes HHW collection sites and other municipal, or commercial recycling facilities).If a location is not already collecting mercury waste, they are exempt from this requirement.
    a. This will also confirm if municipal site mercury intake is preventing TRC from reaching its collection goals.
2. TRC must actively contact retail locations in order to gain more retail sites in NY.
3. Require at least one collection site per county. At least one collection site of each site type per county is preferred.
4. Require at least one collection site per 50,000 residents and at least one per 500 square miles.
5. Collection sites should be located in proximity to population centers.
6. TRC must actively reach out to contractors and provide them bins.
7. Extend requirement that TRC will pay for bins (free to collection sites) but will charge a fee if they are lost

Enhance Outreach and Engagement Programming

Outreach and engagement are important to developing a successful MT collection program. These efforts are most successful when implemented on state and local levels. The Vermont DEC shared that the most effective engagement strategy in their communities was sharing knowledge of the program by word of mouth. Vermont is an example of overcoming demographic barriers through local and specific outreach and education engagement. New York currently does not do this. Whether it be TRC, the Department or a third party, a successful program needs to have a designated representative in the state directly engaging with collection sites and providing them with personalized resource information for education and advertising efforts in their communities (Appendices II and IIIa).

When promoting its MT program, Vermont combines its mercury thermostat advertising with other EPR programs. Each of these programs provides some level of funding to the department to run joint advertising programs and maintain a website that houses the links to EPR and MT programs. This approach consolidates the funding, resources, and consumer attention toward a central message: proper disposal of specialty waste items. By advertising these programs together, the ad will be more relevant to a larger audience since not all consumers will need to recycle a mercury thermostat or leftover paint for example (Appendices II and IIIa).

Other important outreach and engagement aspects are site visits and outreach. In many retail stores, high staff turnover leads to a loss of in-house knowledge and programs become lost in the transition. TRC pays for site visits, calls, and sends postcards to sites that fail to return their bins. Ideally, this outreach should be proactive rather than reactive (Appendices II and IIIa). The Vermont DEC works with TRC to ensure that each site is visited every other year and on the odd year they are called. Site visits are a proven way to maintain the sites that exist and set up new ones.

Additionally, TRC creates educational materials for outreach and engagement. In Maine and Vermont, the Departments worked with TRC to create materials that were more visually appealing and more likely to catch people's attention.

Notably, California has tasked a third party, outside of TRC, to lead outreach and education efforts. California is concerned that TRC has a conflict of interest, since adding more collection sites increases the program's costs (Appendices II and IIIc).

CSMM's recommends enhanced funding for outreach and engagement strategies that will support:

1. Joint advertising with all EPR New York State efforts
   Each EPR program would pay a fee to a PRO or central organization to create instructions on proper disposal. This information could be maintained in a central location, such as Recycle Right NY, with the links to all the EPR programs individual websites
2. Program recruitment outreach and ongoing engagement to retail sites
3. Critical engagement audience will include:
   a. Contractors State License Board
      i. Require that thermostat education and collection be part of the exam
   b. HVAC contractors
   c. Demolition and Deconstruction Companies
   d. Municipalities and HHW Facilities
   e. Property management associations
   f. Homeowners and general public
4. Site visits, every other year
5. Consistent website presence that include up-to-date TRC reports, a collection site locator tool, and free education materials
6. Yearly collection process reports
7. Updated education materials completed by TRC that are reviewed by the Department to and outreach and engagement partners.
   a. Click-ads (on websites and search engines)
   b. Bag stuffers
   c. Posters
   d. Newsletters - Department and third party (like Recycle Right NY)
   e. Radio ads
   f. TV ads
   g. Social media

Implement a Financial Incentive Program

A financial incentive has proven to be an effective way to increase thermostat collection rates, however is only effective if it is tied to strong outreach and convenience measures.

In Maine once the financial incentive was fully implemented in 2008 the program's collection rate significantly increased (Figure 10).

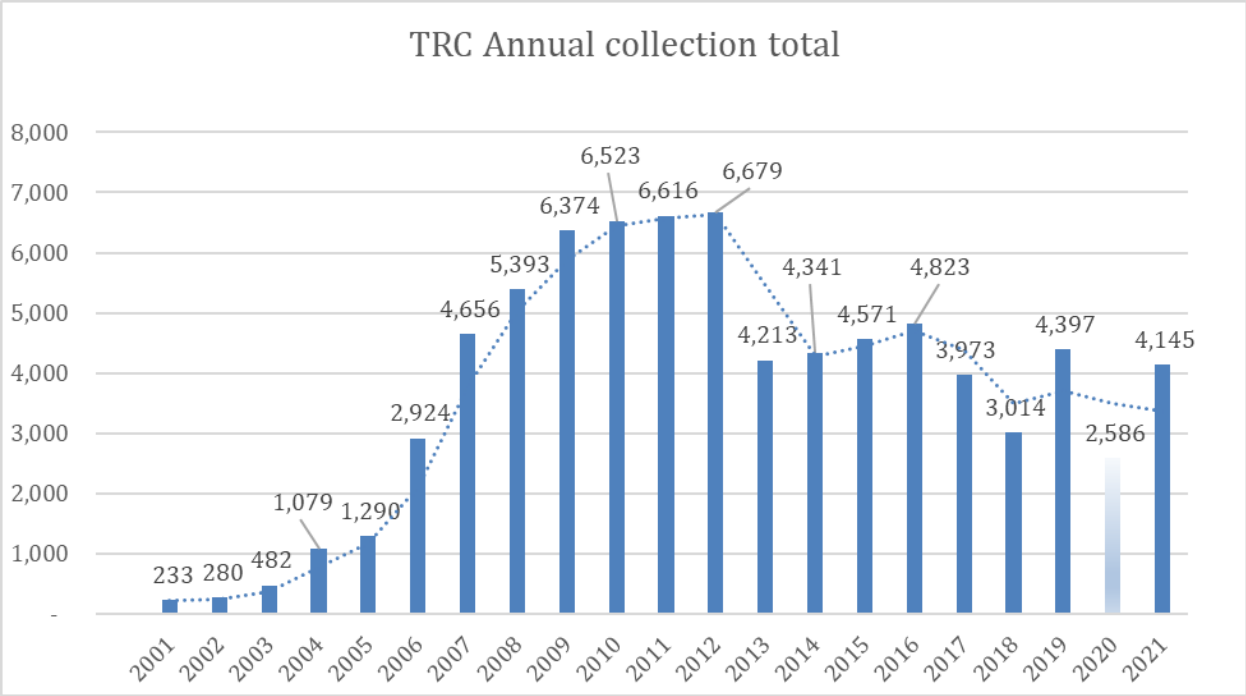

Figure 10: Number of mercury thermostats collected each year of Maine's thermostat Recycling program. This chart was provided by the Maine Department of Environmental Protection. All the data has come from TRC collection reporting.[8]

The Vermont pilot incentive program also demonstrates the importance of incentives. In just two months the incentive collected 1,200 thermostats but the year before that (2006), only 223 thermostats were collected[26].

Maine and Vermont's programs saw higher collection rates when other measures like outreach and convenience were improved by the passing of legislation. The Product Stewardship institute conducted two incentive pilots, one in Oregon and another in Indiana. Each pilot lasted one year and provided similar incentives. The Indiana program only saw a 6% increase in collections but in Oregon, the program's collections increased by 126%. The biggest difference was the Oregon program had an effective outreach and education program[26]. The Illinois Pilot program also came to the same conclusion that the Illinois program did significantly worse than the Vermont pilot due to a lack of community education and outreach[26].

An incentive program's effectiveness is entirely based on whether that program has strong convenience measures and outreach and community engagement to support the incentive. Our recommendation is that New York include a per thermostat incentive of at least $5 in the legislative amendment if effective convenience and outreach measures are included as well.

An incentive may look like:

1. Offer in store coupons at retail sites

    a. Mostly residential consumers won't have many thermostats so they won't want to wait for the rebate in the mail but would rather get the incentive immediately.
2. Offer mail-in rebates for contractors and wholesale sites
    a. Contractors are more likely to return multiple thermostats (whether they have their own bin or drop them off at a wholesale site)so they are more accepting to wait for the larger payout directly from TRC
3. Voluntary rebate at municipal sites
    a. Requiring municipal sites to take on TRC program is already a tough ask
        i. having to deal with incentives is an unnecessary addition to add to the already busy municipalities
        ii. HHW drop offs are more likely to be homeowners who care less about the incentive as they are dropping off small quantities of thermostats so the paperwork is less worth the effort.
4. No limit on the number of thermostats that can be rebated at a time or per individual
5. Provide proof that the thermostat originated inside the state or that the individual returning the thermostat is a NYS resident

Supporting policy

CSMM's recommendations include minimal additions to the existing supporting policies. Potential supporting policies include:

1. Implement a landfill ban, that MTs are not allowed in trash/landfill/incinerator
2. Implement a wholesaler selling ban if manufacturer does not participate and to sell thermostats wholesalers must be a TRC drop off site
    a. Wholesaler requirement - Include/maintain ban that wholesalers may only sell thermostats from manufacturers that are enrolled in the program
3. Requirement for retailers and wholesalers to provide mercury thermostat recycling at point of sale.
4. Requirement for contractors to recycle mercury thermostats
    a. In cases on demolition, deconstruction, or remodeling, mercury thermostats must be first removed and properly recycled
5. Requirement for state agencies to recycle mercury thermostats

Acknowledgements

CSMM would like to thank the members of the following State Departments for providing their time and offering their valuable insight about their statewide mercury thermostat collection programs and legislation in their states: California Department of Toxic

Substances, Iowa Department of Natural Resources, Maine Department of Environmental Protection, Massachusetts Department of Environmental Protection, Minnesota Pollution Control Agency, Rhode Island Department of Environmental Management, and the Vermont Department of Environmental Conservation. The information shared by these Departments was essential for CSMM to develop recommendations for the Mercury Thermostat Collection Act in New York State. Danielle Meyers at the Thermostat Recycling Corporation was especially helpful, kind, and willing to answer our questions.[12]

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Appendices

Appendix I: Statistics for Testing SERA Study Assumptions

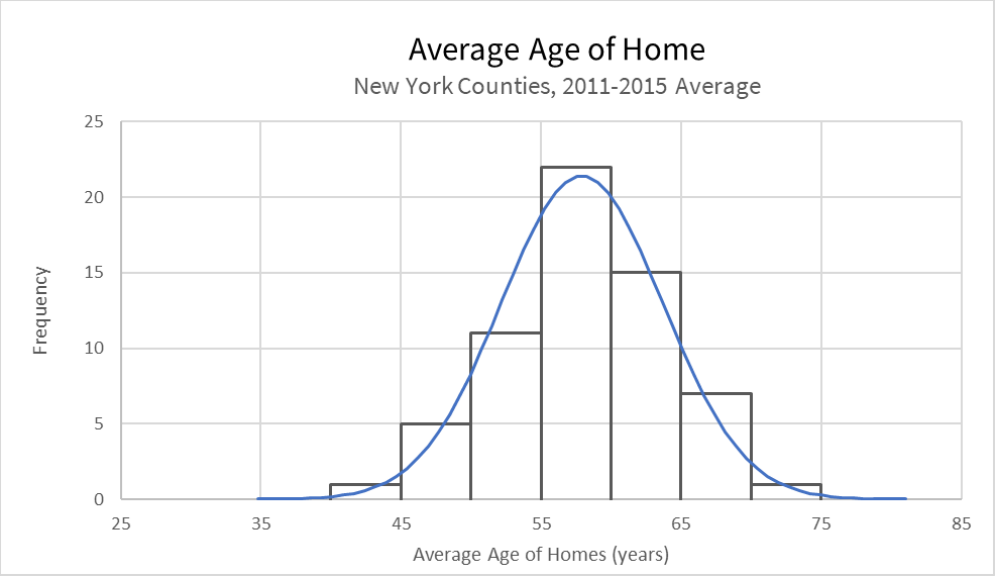

Figure A1: Frequency Distribution of Average Home Age of New York Counties between 2011-2015, overlaid with a Normal Distribution, data source: US Census, 2015B.

Table A1:Summary statistics for Average Home Age in New York Counties between 2011-2015, data source: US Census, 2015B.

Age of Homes	
Observations	62
Minimum [1]	42.76
Maximum [1]	71.73
Mean [1]	57.92
Standard Deviation	5.78
Skew	-0.12
Kurtosis	-0.21
Jarque-Bera Statistic [2]	0.273
p-value [3]	0.872

1: Average home age is estimated. The US Census data was in the format of the number of homes built within a 10 year year range (e.g. Built 2000-2009) from 2014 to "1939 or earlier". The median home age (compared to 2015) for each year built range was multiplied by the number of homes built within that range, and the average was found by dividing the sum by all homes in the county. For "1939 or earlier" we assumed the year built range was 1900 to 1939, and used 1920 as the median year built.

2: The Jarque-Bera test or JB test is a test for normality. The test checks if the skewness and kurtosis match that of a normal distribution. The formula used to obtain the JB test statistic is $JB = (n/6 * (S^2 + (K^2/4))$ where n is the sample size, S is skewness, and K is kurtosis. A large value (>1) generally indicates that the data are not normally distributed.

3: The p-value tests the null hypothesis that the data is normally distributed. This value was found by using the JB test statistic in a Chi-Square test using the excel function "=CHISQ.DIST.RT(x, degrees of freedom)". The JB statistic was used as x, with 2 degrees of freedom. A p-value of less than 0.005 indicates that the data are not normally distributed.

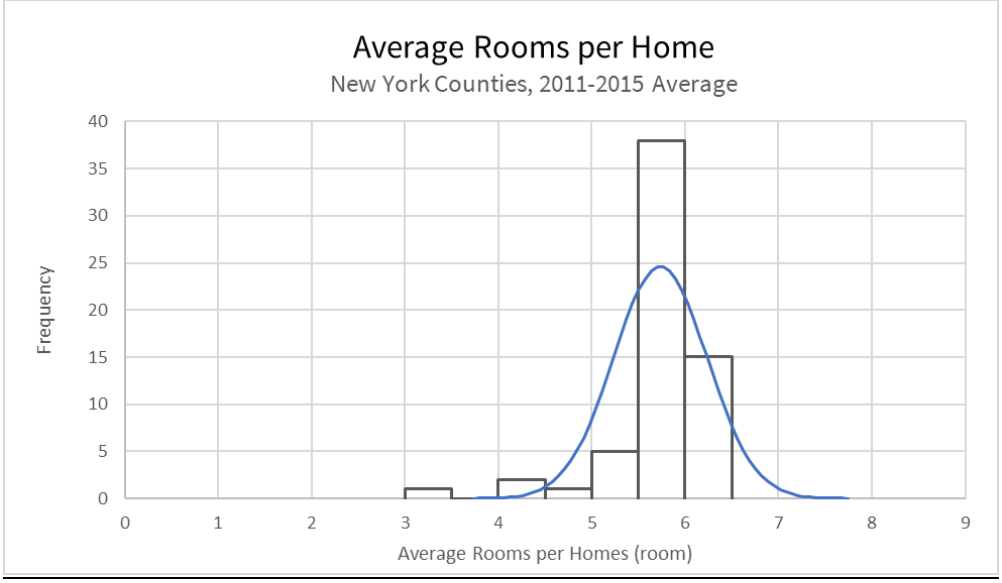

Figure A2: Frequency Distribution of Average Rooms per Home in 2015 of New York Counties, overlaid with a Normal Distribution, data source: US Census, 2015B.

Table A2: Summary statistics for Average Rooms per Home in New York Counties between 2011-2015, data source: US Census, 2015B.

Rooms per Home	
Observations	62
Minimum	3.45
Maximum	6.41
Mean	5.73
Standard Deviation	0.50
Skew	-2.73
Kurtosis	8.75
Jarque-Bera Statistic [1]	274.7
p-value [2]	2.23E-60

*1: The Jarque-Bera test or JB test is a test for normality. The test checks if the skewness and kurtosis match that of a normal distribution. The formula used to obtain the JB test statistic is JB = (n/6 *(S^2+ (K^2/4)) where n is the sample size, S is skewness, and K is kurtosis. A large value (>1) generally indicates that the data are not normally distributed.*
2: The p-value tests the null hypothesis that the data is normally distributed. This value was found by using the JB test statistic in a Chi-Square test using the excel function "=CHISQ.DIST.RT(x, degrees of freedom)". The JB statistic was used as x, with 2 degrees of freedom. A p-value of less than 0.005 indicates that the data are not normally distributed.

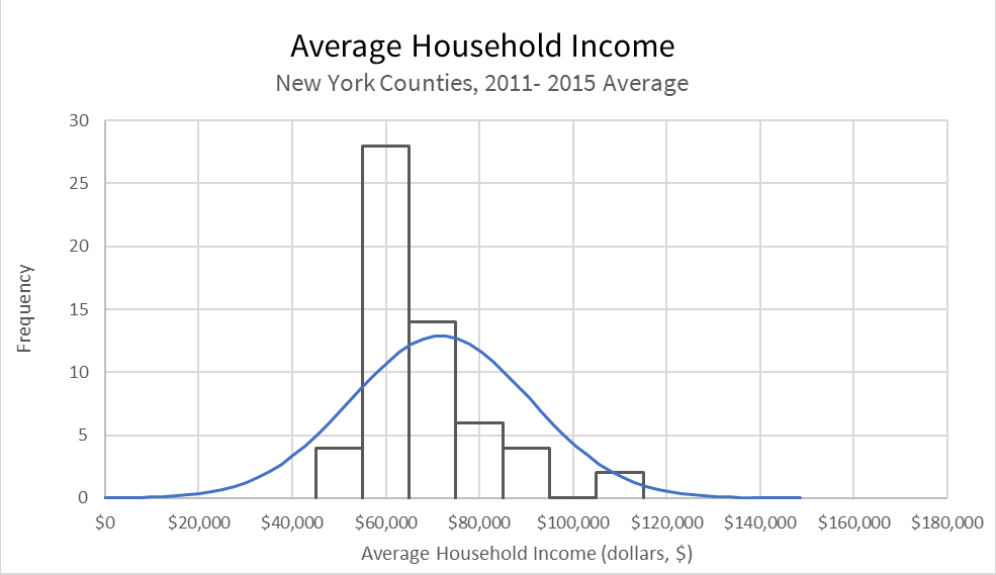

Figure A3: Frequency Distribution of Average Household Income for New York Counties between 2011-2015, overlaid with a Normal Distribution, data source: US Census, 2015C.

Table A3: Summary statistics for Average Household Income for New York Counties between 2011-2015, data source: US Census, 2015C.

Mean Household Income	
Observations	62
Minimum	$50,191
Maximum	$135,687
Mean	$71,671
Standard Deviation	$19,209
Skew	2.02
Kurtosis	3.75
Jarque-Bera Statistic [1]	78.55
p-value [2]	8.76E-18

*1: The Jarque-Bera test or JB test is a test for normality. The test checks if the skewness and kurtosis match that of a normal distribution. The formula used to obtain the JB test statistic is JB = (n/6 *(S^2+ (K^2/4)) where n is the sample size, S is skewness, and K is kurtosis. A large value (>1) generally indicates that the data are not normally distributed.*
2: The p-value tests the null hypothesis that the data is normally distributed. This value was found by using the JB test statistic in a Chi-Square test using the excel function "=CHISQ.DIST.RT(x, degrees of freedom)". The JB statistic was used as x, with 2 degrees of freedom. A p-value of less than 0.005 indicates that the data are not normally distributed.

Table A4: Counties without responses to the SERA report for single-family home, multi-family homes, and businesses

County	**Region**	**Population** (2011-2015 Average)	**Single-Family Homes** (X, if no SF responses)	**Multi-Family Homes** (X, if no MF responses)	**Businesses** (X, if no B responses
Allegany	Western NY	47,979	**X**		
Cattaraugus	Western NY	78,952	**X**	**X**	
Cayuga	Central NY	79,069		**X**	
Chemung	Southern Tier	88,023	**X**	**X**	
Chenango	Southern Tier	49,527	**X**	**X**	**X**
Clinton	North Country	81,429	**X**		**X**
Columbia	Capital District	62,105			**X**
Cortland	Central NY	48,868			**X**
Delaware	Southern Tier	46,811		**X**	**X**

Essex	North County	38,607		**X**	
Franklin	North Country	51,237	**X**		**X**
Fulton	Mohawk Valley	54,407	**X**		
Genesee	Finger Lakes	59,170		**X**	
Greene	Capital District	48,226	**X**	**X**	**X**
Hamilton	North Country	4,759	**X**	**X**	
Herkimer	Mohawk Valley	63,706			**X**
Lewis	North Country	27,047	**X**	**X**	**X**
Livingston	Finger Lakes	64,640	**X**	**X**	
Montgomery	Mohawk Valley	49,745	**X**		
Otsego	Mohawk Valley	61,357	**X**		
Orleans	Finger Lakes	42,122		**X**	
Schoharie	Mohawk Valley	31,946		**X**	**X**
Schuyler	Southern Tier	18,299	**X**	**X**	
Seneca	Finger Lakes	35,140	**X**	**X**	
Steuben	Southern Tier	98,526	**X**	**X**	
Tioga	Southern Tier	50,087			**X**
Tompkins	Southern Tier	102,899		**X**	
Washington	Capital District	62,716			**X**
Wayne	Finger Lakes	92,343	**X**		**X**
Wyoming	Finger Lakes	41,394	**X**	**X**	**X**
Yates	Finger Lakes	25,255			**X**
Total	–	*1,706,391*	*18*	*18*	*15*

Table A6: Summary of Kruskal-Wallis test comparing Average Home Age (structure) between New York State Regions between 2011-2015

Region	*Capital District*	*Central NY*	*Finger Lakes*	*Hudson Valley*	*Long Island*	*Mohawk Valley*	*New York City*	*North Country*	*Southern Tier*	*Western NY*
	p-value									
Capital District	–	0.444	0.311	0.184	0.937	0.080	**0.035**	0.604	0.551	0.105
Central NY		–	0.921	0.055	0.551	0.401	0.227	0.229	0.808	0.441
Finger Lakes			–	**0.019**	0.478	0.390	0.203	0.131	0.690	0.438
Hudson Valley				–	0.435	**0.003**	**0.001**	0.432	0.057	**0.006**
Long Island					–	0.217	0.131	0.797	0.649	0.238
Mohawk Valley						–	0.671	**0.029**	0.231	0.390
New York City							–	**0.012**	0.113	0.203
North Country								–	0.274	**0.042**
Southern Tier									–	0.272
Western NY										–

Null hypothesis: Average household income is the same across New York State regions.
A p-value greater than 0.05 indicates that average household income is significantly different between regions.
***Yellow**: Average home age is **significantly lower** (newer homes) in regions across the top row than the corresponding region in the left-hand column*
***Blue**: Average home age is **significantly higher** (older homes) in regions across the top row than the corresponding region in the left-hand column*

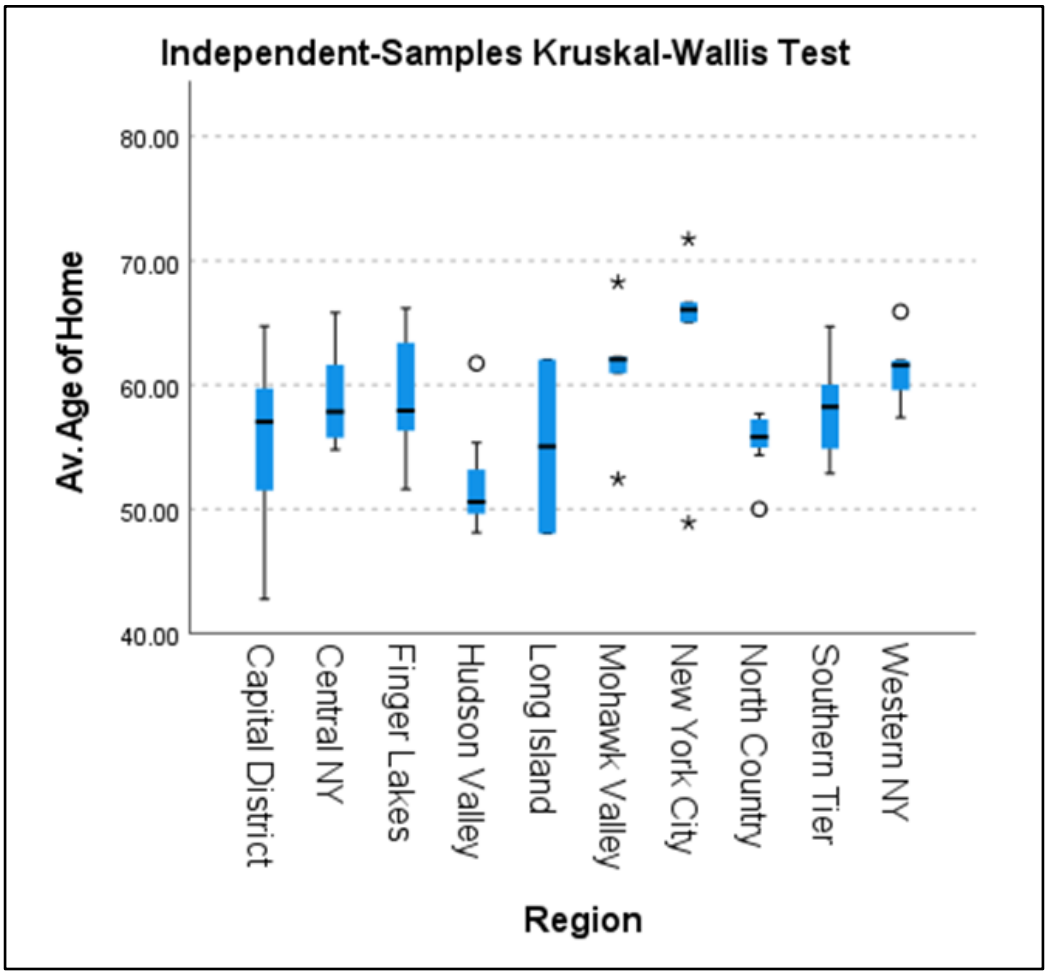

Figure A5: Box and whisker plot showing the distribution of average home age (structure) for New York State regions between 2011-2015

Table A6: Summary of Kruskal-Wallis test comparing Average Household Income between New York State Regions between 2011-2015

Region	*Capital District*	*Central NY*	*Finger Lakes*	*Hudson Valley*	*Long Island*	*Mohawk Valley*	*New York City*	*North Country*	*Southern Tier*	*Western NY*
	p-value									
Capital District	–	0.237	0.073	0.289	0.273	**0.008**	0.848	**0.10**	**0.025**	**0.007**
Central NY		–	0.726	**0.037**	0.066	0.215	0.371	0.259	0.432	0.166
Finger Lakes			–	0.005	0.026	0.293	0.172	0.357	0.604	0.223
Hudson Valley				–	0.693	**0.000**	0.261	**0.000**	**0.001**	**0.000**
Long Island					–	**0.005**	0.244	**0.006**	**0.012**	**0.004**
Mohawk Valley						–	**0.030**	0.872	0.575	0.836
New York City							–	**0.036**	0.076	**0.023**
North Country								–	0.681	0.713
Southern Tier									–	0.453
Western NY										–

Null hypothesis: Average household income is the same across New York State regions.
A p-value greater than 0.05 indicates that average household income is significantly different between regions.
***Yellow**: Average household income is **significantly lower** in regions across the top row than the corresponding region in the left-hand column*
***Blue**: Average household income is **significantly higher** in regions across the top row than the corresponding region in the left-hand column*

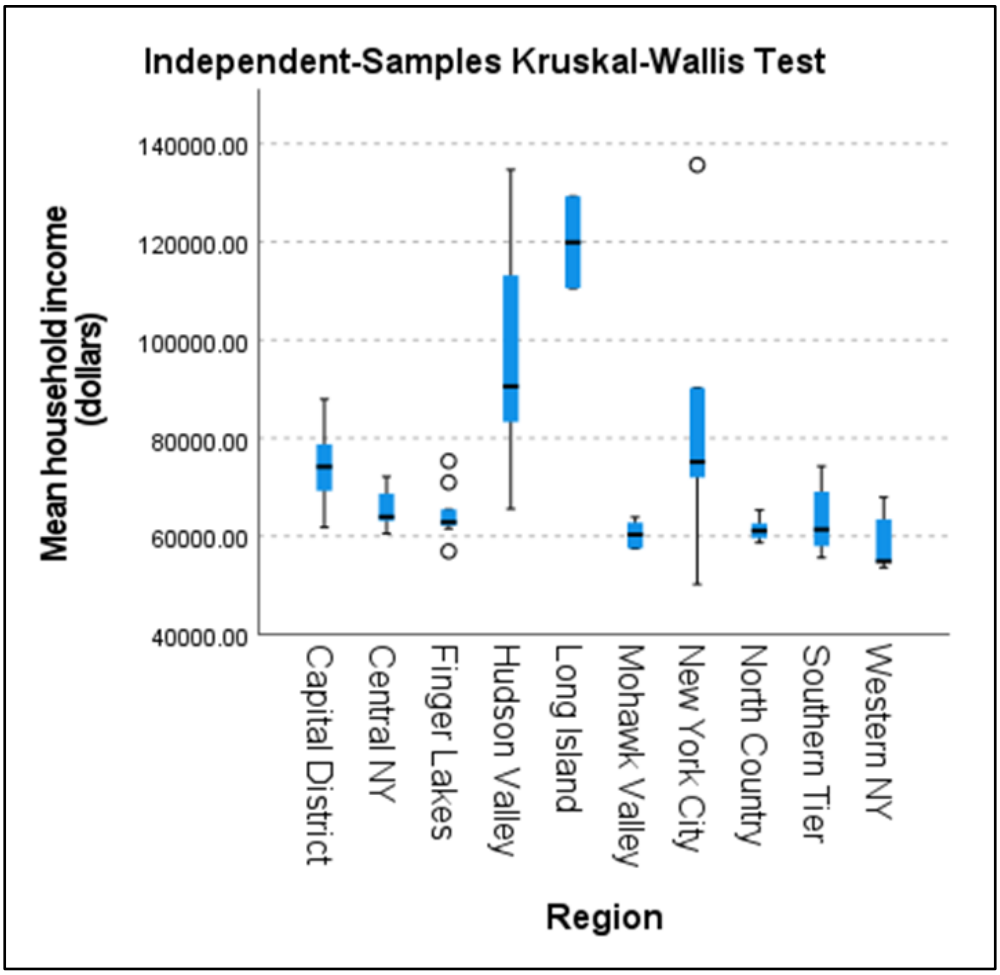

Figure A5: Box and whisker plot showing the distribution of average household income for New York State regions between 2011-2015

Table A7: Summary of Kruskal-Wallis test comparing Average Rooms per Home between New York State Regions between 2011-2015

Region	*Capital District*	*Central NY*	*Finger Lakes*	*Hudson Valley*	*Long Island*	*Mohawk Valley*	*New York City*	*North Country*	*Southern Tier*	*Western NY*
	p-value									
Capital District	–	*0.108*	***0.010***	*0.659*	***0.013***	*0.385*	***0.035***	*0.159*	*0.339*	*0.407*
Central NY		–	*0.541*	*0.240*	*0.206*	*0.460*	***0.001***	***0.005***	*0.442*	*0.483*
Finger Lakes			–	***0.041***	*0.359*	*0.135*	***0.000***	***0.000***	*0.109*	*0.160*
Hudson Valley				–	***0.029***	*0.666*	***0.015***	*0.073*	*0.630*	*0.677*
Long Island					–	*0.065*	***0.000***	***0.001***	*0.058*	*0.073*
Mohawk Valley						–	***0.006***	***0.031***	*0.986*	*0.995*
New York City							–	*0.420*	***0.003***	***0.008***
North Country								–	***0.020***	***0.040***
Southern Tier									–	*0.992*
Western NY										–

Null hypothesis: Average number of rooms per home is the same across New York State regions.
A p-value greater than 0.05 indicates that average household income is significantly different between regions.
***Yellow**: Average number of rooms per home is **significantly lower** in regions across the top row than the corresponding region in the left-hand column*
***Blue**: Average number of rooms per home is **significantly higher** in regions across the top row than the corresponding region in the left-hand column*

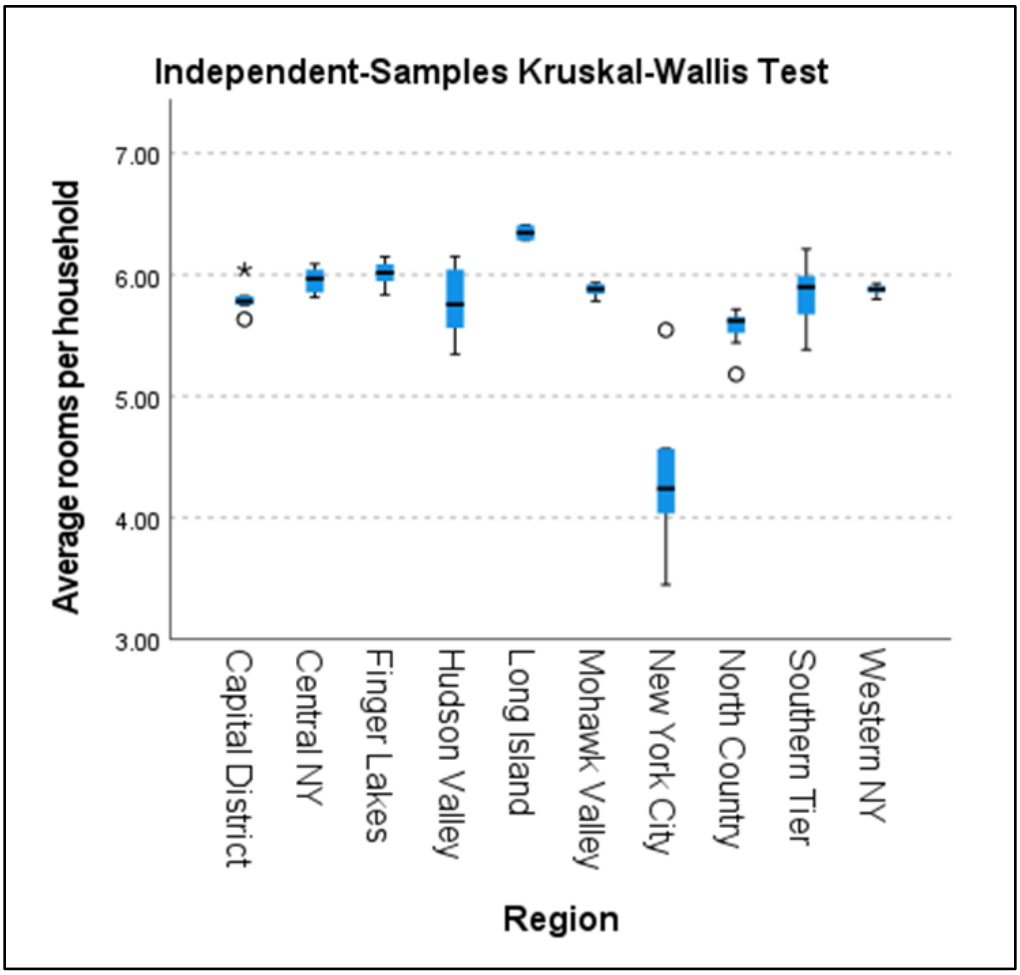

Figure A6: Box and whisker plot showing the distribution of average rooms per home by New York State regions between 2011-2015

Appendix II: Questionnaire with Responses from Other States

Mercury Thermostat EPR Program Questionnaire

NYS Center for Sustainable Materials Management
Kathryn Walker, Executive Director | kjwalker@esf.edu
Delaney Demro, Project Support Specialist | dndemro@esf.edu
Daniel Ricci, Research Aide | djricci@syr.edu

The NYS Center for Sustainable Materials Management (CSMM), administered by the NYS Department of Environmental Conservation (DEC) is conducting an effectiveness study of the NY Mercury Thermostat Collection Act of 2013. Based on the findings of this study, CSMM will develop recommendations for the state to either maintain the current sunset date or extend the sunset date of the Act. Part of this recommendation will include a demonstration of successful strategies implemented by the top performing states with similar mercury thermostat (MT) extended producer responsibility (EPR) policies and programs. Findings from the Product Stewardship Institute's (PSI) Lessons Learned: Voluntary Mercury Thermostat Take-Back Programs report indicate that financial incentives, supporting policies, convenience measures, and outreach & education efforts, performed independently or jointly, contributed to high recovery rates of MTs.

According to the most recently available data, [state] was one of the top performing states for MT recovery per capita. For this reason we would greatly value your responses to the following questions. Please answer each question below in the space labeled "Response". If possible, please provide any supporting documents that may clarify your response. If information is not available to answer a question, please note this with "N/A". Please return the questionnaire to Daniel Ricci, djricci@syr.edu, by the close of business on Wednesday, June 29th.

Key

- California: **CA** (blue)
- Maine: **ME** (red)
- Minnesota: **MN** (gold)
- Rhode Island: **RI** (purple)
- Vermont: **VT** (green)

State-Specific Questions

1. **California**: How was it determined that the thermostat collection bill would sunset in 2030? What was the motivation behind selecting this date?

   A sunset date was selected because over the next several years it is anticipated that most of the last remaining mercury-containing thermostats will be removed through remodels, upgrades, and demolition. On or before January 1, 2028, the Department of Toxic Substances Control (DTSC) will report to the Legislature on the status of the program.

2. **Maine**: The Maine legislation states that the monetary incentive would be adjusted depending on the reports by manufacturers. Has the incentive been changed? Is the data or report this decision was based on available?

   The incentive has remained at the minimum amount set in statute of $5 per mercury thermostat since the program's inception. There is no documentation that I've seen that clarifies why $5 was pinned down as the right number, but I can share documentation that gets at why a financial incentive was chosen as an effective mechanism to boost collection of mercury thermostats

3. **Maine**:The Maine legislation states that the monetary incentive would be adjusted depending on the reports by manufacturers. Has the incentive been changed? Is the data or report this decision was based on available?

   The financial incentive was chosen as a motivating factor to encourage recycling; previous attempts to capture mercury thermostats had limited impact and given the high recovery rates achieved by collection programs with financial motive (for example, the $0.05 - $0.15 per beverage container redemption value has boosted Maine's collection and recycling of beverage containers over the years), it made sense to go with a financial reward for properly managing mercury thermostats.

4. **Minnesota**: When the Minnesota thermostat collection law sunset, were collection rates affected? If so, how?
   a. Was there a change in the state's relationship with TRC?

   There is no sunset to the Minnesota mercury thermostat collection law. Minnesota established the program in partnership with Honeywell between 1991 and 1995 and we had a very good working relationship to establish a universal waste-like regulatory system that allowed Honeywell to establish four types of collection systems in Minnesota and expand those outward as programs were established in additional states. When TRC took over, there was not the same type of partnership and by 1999, TRC ended all collection programs except the wholesaler reverse distribution collection program.

5. **Rhode Island**: How did you determine your collection goals? Did the RIDEM use the SERA report? The center plans on using the 2014 New York State SERA report for our empirical basis. Do the SERA reports have any shortcomings we should be aware of?

   RIDEM reviews the SERA report and bases collection goals on TRC past collection rates, market information, existing data from other states, and IMERC data on mercury thermostats. The 2014 NRDC SERA report suggests that the annual average flow of mercury thermostats for years 2020-2024 is 9800 thermostats annually. RIDEM considered the SERA values to reflect a much higher number of thermostats available for collection than was reasonable for consideration when proposing the 2021-2022 collection goals.

6. **Rhode Island**: When creating the collection goals for 2021 and 2022 why did the RIDEM lower its collection goals after public commenting from TRC?

   A comment was made by the TRC that setting a collection goal halfway through the year for 2021 that is higher than the previous target is unreasonable. In response to that comment, RIDEM set the annual collection goal for 2021 and 2022 at 4000. In addition, these final goals are consistent with the TRC collection rates from 2015-2020 and the collection rates prior to the pandemic.

7. **Vermont**: Did the Vermont thermostat collection bill sunset?
   a. If not, why has reporting and/or collection stopped in 2016?

      No. Collection has not stopped. The reporting requirement terminated because of an error in the legislation that eliminated other reporting and by accident also eliminated the TRC reporting. TRC still provides quarterly collection numbers to us and the rest of the previous reporting has proven to be insignificant. TRC was on board with correcting the elimination of the report and it was included in a bill that didn't pass.

Monetary Incentives

1. How was it determined that [state] would implement a monetary incentive for mercury thermostat (MT) recovery?

   CA: California decided to implement a monetary incentive for MT recovery based on the knowledge that states with financial incentives have much higher mercury-added thermostat collection and recycling rates than the states that do not. Maine and Rhode Island, for example, required incentives to be provided. When drafting AB 707, California determined that it too would implement a monetary incentive to encourage greater collection success.

   ME: The financial incentive was chosen as a motivating factor to encourage recycling; previous attempts to capture mercury thermostats had limited impact and given the high recovery rates achieved by collection programs with financial motive (for example, the $0.05 - $0.15 per beverage container redemption value has boosted Maine's collection and recycling of beverage containers over the years), it made sense to go with a financial reward for properly managing mercury thermostats.

   MN: Minnesota does not have a monetary incentive for thermostats.

   RI: NA

   VT: VT followed Maine's lead on this. The first year of the legislative session ME and VT were both exploring incentives. ME successfully passed an incentive for the wholesale return of thermostats but did not manage to get anything for the retail sector as far as incentives. VT decided to put together a two-month pilot project during the fall of that same year at the retail level. We were able to get TRC to donate the bins for the hardware stores and we put together outreach materials. During that two-month period just at the retail level we collected about three times

more than during any year of collection under the voluntary methods at the wholesale level. This is a very old report and then our offices flooded - but, I can look for the report.

2. Was there empirical evidence to support this decision?

   CA: In deciding whether to implement an incentive, California noted that some states, including Maine and Vermont, require manufacturers to pay a financial incentive to persons delivering mercury thermostats for recycling. California also used Rhode Island as a case study. In 2013, Rhode Island conducted a pilot program that set performance goals and utilized a $5 financial incentive. For 2011 and 2012, 1,416 and 1,543 thermostats were collected, respectively. Since the introduction of $5 incentive, the State program recovered 2,618 and 2,720 units for 2013 and 2014, respectively, which is an increase of over 76 percent. The $30 amount was determined through negotiations.

   ME: It is not clear based on the documents readily available to me what supporting data was relied upon for the decision. A Plan to Improve the Collection of Mercury Thermostats, which was Presented to the Joint Standing Committee on Natural Resources By the Maine Department of Environmental Protection on January 15, 2004 indicates that a survey of Maine wholesalers and contractors conducted in the early 2000s suggested that a monetary incentive could boost participation. Further, among the recommendations of that report it is noted that "The bounty program should be further explored and evaluated if TRC fails to achieve an interim recycling goal of 50% by February 2006." Again, based on the available information, it appears TRC failed to meet the interim recycling rate.

   MN: NA

   RI: NA

   VT: Our pilot project was instrumental in securing the incentive for DIY Vermonters.

3. What did the incentive look like? Was the incentive offered as a flat rate, store coupon or discount, or a rebate for a modern thermostat? Was there a cap or limit to the incentive award per person?

   CA: The Mercury Thermostat Collection Act of 2008 did not specify how incentives would be offered or distributed. The new $30 incentive is a requirement of the Mercury Thermostat Collection Act of 2021 (MTCA 2021). The qualified third party plans to send a check to the residence listed on the incentive form once the retort facility receives the thermostat. It has not yet gone into effect, as the qualified third party (QTP) plan was submitted on June 1, 2022 and DTSC has not yet made an approval determination. MTCA 2021 requires that an incentive of no less than $30 be provided to individual residents of California who return an out-of-service mercury-added thermostat to an established collection location and who are not retailers or wholesalers. There is no limit per person, but the person returning the thermostat must attest to their California state residency and that the returned out-of-service

mercury-added thermostat or thermostats were removed from a building or facility in the state.

ME:The incentive process has been streamlined over time but was quite cumbersome at one time. I can provide additional documentation if past practices are of interest. Currently, there are two incentive models:

Retail: People can bring mercury thermostats to a participating retailer and receive a $5 off coupon (per MT) for the store. The retailer collects mercury thermostats in a bin provided by TRC, which it must ship within a year or the bin is full (as per universal waste storage regulations), or if they want to redeem the coupon values sooner. The retailer sends the bin in with a rebate form specifying how many mercury thermostats they gave out coupons for, which must match the number in the bin. TRC then sends the retailer a reimbursement check.

Wholesale/contractor/municipal site: People bag up to ten thermostats in one large ziplock bag with a claim form that contains their name, address, and the number of thermostats returned in that bag. When the collection location sends the bin in for recycling, TRC gets this information and mails the people who turned in thermostats checks. The drawback here is that people turning in large quantities have to follow this somewhat cumbersome process of filling out one form for every ten thermostats. However, this process is preferable to the old process that was even more convoluted.

MN: NA

RI: NA

VT: The $5. Rebate is a check that is sent to the customer when they drop off at a wholesaler or at a Solid Waste District/transfer station. Hardware stores provide a $5. Coupon off anything in the store. When they mail back their collection container, they put the number of thermostats in the bin and the hardware store gets a check to reimburse them for those coupons.

4. What funding was necessary (budget) to implement the incentives? How much of the policy's total budget was allocated to this? Who funded this incentive?

   CA: According to California Health and Safety Code (HSC) section 25214.8.11.5(g)(1), a qualified third party selected by a manufacturer, or group of manufacturers, to develop and implement the program shall provide out-of-service mercury-added thermostat collection incentives to consumers of no less than $30 per out-of-service mercury-added thermostat collected. MTCA 2021 also established an annual payment schedule stating how much a manufacturer or group of manufacturers must pay each year to the qualified third party to carry out the education and outreach campaign required by the Act. We do not know how much the manufacturers plan to budget for incentives specifically.

   The manufacturers are responsible for funding the incentive under MTCA 2021.

ME: If referring to DEP's funding, the fiscal note associated with establishing the incentive program indicated any additional costs to the Department of Environmental Protection to review the financial incentive plans of certain manufacturers of mercury-added thermostats and submit a report to the Legislature are expected to be minor and can be absorbed within existing budgeted resources.

Thermostat manufacturers, but work went into identifying them and with figuring out who would participate by paying through TRC – in the early days, some companies chose to contract with a ME HHW management company.

MN: NA

RI: NA

VT: The incentives are paid directly by TRC. The funding was my salary when I started setting up hardware stores - I trained on how to participate in the program - We developed posters- then TRC developed some of those materials. We were very involved. At first, we did fund the costs of the bins; but, later those bins were provided at no cost.

TRC.

5. Can changes in MT recovery rates be attributed to the incentive (alone or jointly with other efforts)?

CA: The $30 MT collection incentive has not yet gone into effect. A 2016 DTSC-issued consent order required manufacturers to develop a pilot project plan that included pilot projects designed to assess the effectiveness of the use of monetary and other incentives to increase program participation and the number of mercury-added thermostats collected.

ME: Maine's capture rates for mercury thermostats increased substantially during the first seven months of the incentive program. When Maine's contractor program was instituted in May 2007, the real impact of the incentive was apparent in a comparison of yearly May- December numbers. In 2006 May- December 1609 thermostats were returned in 17 bin shipments. In 2007 the May- December returns more than doubled, with 3516 thermostats returned in 47 bins. This clearly demonstrates that the incentive had a positive impact on capture rates. As shown in the graph below, collections further increased in 2008 when the $5 retail incentive was incorporated into the program. Other than 2020, when collections were impacted by the pandemic, collection rates have remained above pre-incentive rates.

MN: NA

RI: NA

VT: My opinion is that it is a combination of several things. DEC promoted this widely through word of mouth and printed materials primarily…bag stuffers at hardware stores (hardware stores did their own promotions as well)... solid waste districts promoted the program… TRC did some promotions… The $5. Incentive was

definitely something mostly in the beginning that prompted individuals to bring the thermostats into a collection site. The landfill ban is also essential to making this work. Then we banned the sale of these devices. We worked with Efficiency Vermont and they also promoted to their contractors - rural contractors can also have their own collection "pail" in VT and Efficiency VT purchased some of those pails and gave them to the contractors they worked with… The benefit of a small state is getting the word out using "word of mouth". In the last few years, we worked with all of the EPR representatives and each program contributes the same amount of funding for a combined EPR in-state outreach effort.

Supporting Policy

6. What supporting policies (e.g. landfill ban, etc.) were implemented?

CA: California laws prohibit the disposal of mercury-containing thermostats in municipal waste receptacles and landfills. Out-of-service mercury-added thermostats are handled as universal waste in California.

ME: There is a disposal ban on mercury thermostats.

Any manufacturer not in compliance with Maine's law can't sell thermostats into the state.

- Wholesalers and retailers are also banned from selling any non-compliant manufacturer's thermostats.

Wholesalers are required by law to serve as collection sites for mercury thermostats.

- If a wholesaler is non-compliant with the collection requirement, they are prohibited from selling any thermostats.

MN: Solid waste disposal prohibition. Outreach to wholesalers and contractors in MN in cooperation with Honeywell, when the in-state program was run by Honeywell.

RI: Compliance guidance and submittal of collection plans through IMERC

VT: The landfill ban on most mercury-containing products was there when the law was implemented in 2008. Thermostats are universal waste in VT. In addition, the provision in EPR laws which is the most effective in promoting manufacturer participation in a collection program - is to restrict the sale of products. In this case, no thermostats (even non-mercury) can be sold if a manufacturer is not participating in the collection program.

7. Was this policy enforced, monitored, or measured? If so, how?

CA: If a manufacturer fails to make a payment required by the act, the manufacturer's thermostats shall be subject to a sales ban. DTSC's Enforcement and Emergency Response Division has made a list of 35 different contractors, retailers, wholesalers, and other collection locations to inspect for compliance with MTCA 2021. According to the act, no later than July 1, 2023, and no later than July 1 of each year thereafter until July 1, 2028, the qualified third party shall conduct an annual survey to evaluate the effectiveness of the education and outreach campaign

developed by the qualified third party. The qualified third party shall review the annual survey responses and public comments and, if warranted, by November 1 of the same year, submit to the department for its review and approval proposals to modify the program.

ME: Yes, DEP staff performed regular technical assistance visits to collection sites to ensure compliance and also confirm whether there were issues with receipt of reimbursement by TRC (there were, particularly in the earlier days of the program, usually related to one part of the complicated coupon and paperwork system TRC required for reimbursement being missing or incorrect. DEP staff still conduct technical assistance visits, trying to visit each site annually and coordinating with TRC to avoid visiting the same sites their consultant visits. DEP staff also review TRC's annual program report and provide feedback on overall program performance. There have also been semi-regular meetings with TRC, particularly in the earlier days of the program, some of which included stakeholders from other organizations like larger wholesalers, PSI, etc.

MN: Difficult to find thermostats in solid waste. Goal of the disposal ban was education about mercury and the Honeywell/TRC collection programs, plural.

RI: Please contact IMERC for data on the number of collection plan applications submitted to IMERC

VT: The mercury thermostat law has a provision that required a 65% recycling goal for all available thermostats. DEC (the secretary actually), according to the law, was to make that determination of the number of available thermostats. That didn't happen in 2010 as required by law because there were no resources. VPIRG and Dave Linette's organization brought this to our attention a few years after I started overseeing the mercury program again. There was substantial work to look at other reports that were conducted in other states (CA, ME, RI) and extrapolate those numbers to apply to VT. That extrapolation number was not something we felt we could hang out hats on. Instead, we worked with TRC to focus on outreach efforts to increase collection rates and get the word out about the rebate program. Since then, we partnered with our state's weatherization programs to add a question to their weatherization inspection reports to see how many thermostats are still in use. In addition, we have worked with the utilities to promote change outs and the weatherization coaches are also doing some change outs themselves. This can be a challenge given the wiring needs of mercury thermostats vs. the needs of newer/smarter thermostat replacements. Some incentives are possible through Efficiency VT - But energy savings are difficult to gauge and commonly not able to be incentivized.

8. What funding was necessary to enforce the supporting policy? How much of the policy's total budget was allocated to this?

   CA: The manufactures are required by MTCA 2021 to pay to DTSC an aggregate total of up to $400,000 annually upon appropriation by the Legislature. In part, this

money may be used for DTSC's actual and reasonable regulatory costs in administering, implementing, and enforcing the act.

ME: The State does not have an annual budget allocated specifically for this program. TRC reports on their annual program costs in their annual reports.

MN: No funding for enforcement. Funding supported staff who worked with Honeywell to develop the regulatory framework and promote the initial collection programs.

RI: No funding for the thermostat collection program

VT: No funding was specifically allocated to implement other than my staff time. The law passed, the Hg position was eliminated and I set up hardware stores as collection sites prior to my move.

Convenience Measures

9. Has [state] considered the convenience of MT collection sites when determining permitted collection site types (e.g. retail, wholesalers, municipal governments, etc.) and site locations?
    a. If so, has this changed the structure of collection sites (spatial distribution or type of collection site) over time?
        i. What funding was necessary to implement this restructure?

CA: The collection locations are identified by the qualified third party based on the requirements stated in HSC section 25214.8.11.5.(b)(1). NA

ME: The statute has no requirements or parameters for convenience, as noted below.

MN: MN has worked hard to ensure that every household hazardous waste program in the state (which covers the entire state) collects thermostats and has TRC bins to use the TRC program. We paid for the bins for the HHW programs when TRC charged the fee. When the Honeywell program started, most of the HHW programs were in it, then TRC kicked them out and would not work with them for 10+ years. HHW monies in the state budget.

RI: N/A – TRC sets up the collection sites

VT: Not really. VT does not have a lot of big-box stores so smaller hardware stores are common in most communities. Participation is optional. Most waste collection facilities of any size participate in the program. Wholesale distributors throughout the state are required to participate in the collection program. Rural contractors can have their own collection pail that can hold around 6-10 thermostats

Staff time.

ii. Can changes in MT recovery rates be attributed to this restructure? If so, how?

CA: NA

ME: NA

MN: When the HHW program participation was reinstated, we again had a dropoff program convenient to residents of the state, and businesses can also use the HHW programs for mercury devices such as thermostats.

RI: NA

VT: The incentive increased recycling rates.

10. Has "convenience" been defined in terms of collection site distribution? If so, how?

CA: Yes. MTCA 2021 requires that the locations and methods established pursuant to the program to collect out-of-service mercury-added thermostats are sufficiently convenient in all parts of the state, including within rural communities, disadvantaged communities, and low-income communities. It defines "sufficiently convenient" as, for at least 90 percent of state residents, a collection location is located within 15 miles of their residence, and at least one collection location in each county in the state, unless there is no collection location in the county that is required to participate under this act or willing to participate voluntarily.

ME:Not in the statute that guides the MT program. However, we do have convenience criteria in our paint (https://legislature.maine.gov/statutes/38/title38sec2144.html) and mercury lamp (https://legislature.maine.gov/statutes/38/title38sec1672.html) statutes and based on the distribution and location of MT collection sites, the MT program provides similar access as the paint and lamp programs.

MN: No.

RI: NA

VT: No- the waste that is being collected here is a waste that has been banned from the landfill since July of 2007. The voluntary program had a rough start with wholesale facilities- once the incentive was added and those facilities were mandated to collect, the facilities stepped up their efforts primarily due to the demand of the contractor's $5. incentive. The addition of hardware stores and solid waste facilities created a good distribution of collection options. Aubuchon stores which are corporate owned had more difficulty with the reimbursement process than did the independently owned hardware chains. Plus the independent hardware stores are commonly looking for opportunities to provide services to their customer that are not as readily available at a corporate level. Corporately owned facilities, such as Home Depot, Lowes, etc. conduct programs on a National level where everything is equal from store to store.

11. Does [state] track MT collect from household hazardous waste (HHW) collection sires state-wide?
    a. If so, are these numbers included in the TRC reports?

    CA: Yes. Collection from HHW collection sites has been reported in TRC's annual reports up until this point. Moving forward, the MTCA 2021 requires the qualified third party to submit an annual report which includes, among other things, the names and locations of all participating out-of-service mercury-added thermostat collection locations and the number of out-of-service mercury-added thermostats collected at each collection location.

    ME: The State of Maine regulates mercury thermostats as universal waste. Generators of universal wastes must ship and track their waste using a Uniform Hazardous Waste Manifest, a Uniform Bill of Lading, or an alternative form approved by the Department. We track this data internally. See this webpage for more information. The data from TRC is limited to MT collected in TRC bins, which could also include any HHW locations participating in their program.

    MN: Yes, we do, and they should be in the TRC reports.

    RI: RIDEM does not track it, however, Rhode Island Resource Recovery Corporation may track MT collected through their Eco-Depot program (link below) https://www.rirrc.org/recycling-composting-disposal/hazardous-waste/household-hazardous-waste

    VT: Yes - TRC provides collection numbers for all participating locations.

Education & Outreach

12. What did the program's education and outreach efforts (e.g. postcards/mailers, radio or TV ads, in-person marketing, etc.) look like in [state]?

    CA: On or before June 1, 2022 the qualified third party was required to submit to DTSC for review and approval a mercury-added thermostat education and outreach plan. DTSC has not yet made an approval determination for that plan, but, based on the plan, we have an idea of what education and outreach efforts might look like. These efforts might include creating a website with mercury-added thermostat collection information, creating audience-specific informational materials, developing ads for trade media platforms, conducting outreach to existing partners, collaborating with community-based organizations and producer responsibility programs, among other tactics.

    Under the previous act, MTCA 2008, DTSC sent out postcards with information about mercury-added thermostat collection.

    ME: This has varied over time but included newspaper ads (print and now online), postcard and, more recently, telephone reminders to participating collection sites to ship their bin if past due, hiring a consultant to visit a limited number (less than 30) of

participating sites to check in and help them ship past due bins. In the past, a PSA was run but that is not a typical aspect of the campaign. TRC provides print materials for collection sites to post, such as a poster and window cling for the front letting people know they can bring MTs in for recycling.

MN: Direct mail and phone contact with wholesalers and contractors, repeated periodically.

RI: RIDEM relied on Thermostat Recycling Corporation to provide education & outreach

VT: TRC is a national organization and primarily advertises in national trade journals to target the contractor audience primarily. But, in their Plan, there is mention of some local advertising. We pulled the EPR programs together and on a annual basis, all five program contribute a small sum to run TV, and FPF (Front Porch Forum- paid email advertising that has been very effective) ads. This EPR outreach group has utilized newspaper ads, bus advertisement, radio, TV, banner ads, FPF ads. All advertising has been developed and can be used by solid waste entities in the state as well to promote these programs. A combined brochures (all 5 programs) is handed out by facilities at HHW events, farmers markets, town clerks distribute them, etc. The brochure has been translated into 8 languages and is available on line. The TV ad has been translated into Spanish - and it has been modified recently to include the language options available on the website. One website location is utilized for the advertising, one county look up, and one toll free telephone number to answer questions for all five programs. With the one website vtrecycles.com (go to special recycling) residents can check where they can drop off their waste products for recycling. Each EPR program still maintains their own sites - but the joint advertising utilizes one web location and then we are able to pull analytics during the advertising spans and monitor effectiveness. The manufacturer programs appreciate that. Also, with EPR programs it is not easy to keep track of participants. The EPR group combined their facility lists, updated those lists based on any address changes, closures, name changes, etc. and tries to keep that list maintained for accuracy. Sometimes we find out about a retail location closure when someone calls the hot line and then tells us that the facility is not closed. We all have to work together to keep those lists up-to-date.

13. What funding was necessary to perform these efforts? How much of the policy's total budget was allocated to this?
    a. Was there additional funding outside of that reported by TRC?

CA: Mercury-added thermostat education and outreach is funded by the manufacturers. The manufacturers must adhere to an annual payment schedule outlined in the act.

ME: It varies, but for years 2015-2021, education and outreach comprised about 35% of the program's budget. See table below for details. Beyond staff time for

technical assistance visits to collection sites, DEP does not have funding or budgeting to do education and outreach.]

	2015 Costs	2016 Costs	2017 Costs	2018 Costs	2019 Costs	2020 Costs	2021 Costs	Total	% of Total Costs	Avg
Direct Expense for Marketing & Outreach	$8,405	$7,052	$15,285	$20,676	$29,871	$28,918	$35,480	$145,687	35%	$20,812
Incentive/Promotional Payments	$17,495	$15,061	$21,513	$14,765	$15,136	$12,391	$15,195	$111,556	26%	$15,937
Legal	$11,103	$180	$ -	$3,000				$14,283	3%	$3,571
New Collection Containers			$ -	$ -				$ -	0%	$ -
Recycling Costs	$7,999	$7,761	$14,030	$12,617	$17,344	$10,699	$18,105	$88,556	21%	$12,651
Legal			$ -	$ -				$ -	0%	$ -
Travel	$2,435	$3,170	$ -	$142	$1,336		$1,658	$8,741	2%	$1,457
TRC Staff and Administration	$9,604	$13,879	$3,800	$9,742	$4,618	$4,150	$7,298	$53,091	13%	$7,584
Total	$57,040	$47,103	$54,628	$60,942	$68,304	$56,158	77,736	$421,912		$60,273

MN: Honeywell funding initially, then part of state employee's jobs.

RI: NA

VT: No. For the EPR outreach group - each group contributed the same amount and outreach is conducted with that amount. For more recent EPR programs, the budget is part of the plan, etc. for these older programs, that will depend sometimes on the contributions that the PSO is receiving. The joint efforts really have proven to be beneficial to help with the financial needs of smaller programs and the residents are more responsive to a joint advertisement that has potential to connect with more people than a solitary message about one waste.

Final Questions

14. Of the strategies mentioned above, which has [state] found to be the most contributing factor to MT recovery? Why?
    a. Monetary incentives
    b. Supporting policies
    c. Convenience measures
    d. Education and outreach
    e. Other

    CA: In response to a DTSC-issued consent order, the manufacturers created a new plan in 2017. It required many updates to the plan, including site visits and contacting non-participating collection locations. These updates led to a spike in collections. Overall, California has found a mix of strategies contributes best to effective MT recovery. Incentives are important, and so are convenient collection locations, especially for rural communities, low-income communities, and disadvantaged communities.

    ME: As shown in the attached spreadsheet, the collection data supports the point that monetary incentive is the most important factor for MT recovery.

    MN: Our focus has been education and outreach plus HHW program collection, plus trying to ensure that every wholesaler is in the program and it is visible in their business. As mentioned above, Honeywell started with four programs. Reverse distribution through wholesalers, HHW program collection, direct mailback by consumers with Honeywell-provided postpaid mailer, direct return to Honeywell by entities generating quantities, e.g., demo contractors, remodelers, etc.

    RI: The contributing factor to the success of the RIDEM thermostat recovery program would be our joining IMERC and providing a regional, consistent solution to this issue.

    VT: a, b, d, Vermonters are receptive to the idea of keeping mercury out of the environment as long as it is convenient and free. Our solid waste districts/municipalities are amazing in my eyes and without them, it wouldn't be as successful.

15. Is there anything else you would like to share about [state]'s MT recovery program?

    CA: NA

ME: The program has been running more smoothly in recent years, thanks in no small part to Danielle Myers who has been a pleasure to work with and very responsive and helpful both to DEP staff and to collection sites needing assistance. While education and outreach undoubtedly could have been much more robust over the years, all of the data supports that the financial incentive is an important factor in ME achieving higher per capita MT recovery rates than states without.

MN: We would like to TRC to operate multiple programs, including the mailback program, which was the single most successful collection program but some people at Honeywell and TRC saw it as too expensive, 2 to 3 dollars for collection of a thermostat, at a time when Honeywell's cost to manufacture a mercury thermostat was 2 to 5 dollars, to the extent we could determine their mfg cost.

RI: NA

VT: Any questions, please do not hesitate to contact me [phone number omitted]

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Appendix III: Interview Questions and Responses from Other States

The questions documented here reflect the planned questions going into the interviews with each state department. Responses shown reflect the notes CSMM staff took during the interview and were not transcribed verbatim. Based on their responses, supplementary and clarifying questions were posed. We captured their responses to these additional questions as part of their response to the original questions.

Appendix III-a: California Interview Questions and Responses

1. What information was used to determine the sunset date? Based on the findings of the 2028 Department of Toxic Substances Control study, could the sunset date be extended?
    a. What will be needed to require this study be performed? Why was DTSC chosen to perform this study and not SERA or another 3rd party?
    CA:DTSC not involved in creating the 2021 MTCA, this was determined through negotiations between the legislature and manufacturers

2. What was the conversation with TRC like when setting the $30 incentive?
    CA: No answer since this was done with the legislature, the 2008 version TRC failed to meet some requirements that were set, a lot of the plans look like that is in the new 2021 version. Meal tickets and discounts were offered

3. Does California have a smart thermostat replacement program? Was the $30 incentive designed to help cover some of the cost of a modern thermostat?
    CA: They exist at the PUC or Energy Commission - different departments, local efforts indirectly related but not formally part of this process, TRC has qualified 3rd party as a strategy to expand outreach. 2019 CC Energy Code, requires new thermostats are digital for new HVAC installation

4. Can you share any of the data that you received from Rhode Island concerning their pilot program? They were not able to provide information on the financial incentive program.
    CA: Bill history and that mentioned Rhode Island - currently do not have any additional information about this, but they will check their drives for supplementary documentation. Created by legislation so not

5. Can you provide documentation regarding the incentive pilot programs you have done?
    CA: Resources are on their website - probably in the archives: https://dtsc.ca.gov/toxics-in-products/mtca-2008-compliance/
    Look into TRC website too

6. Does the CA DTSC perform site visits or is this done by TRC?
   CA: Enforcement folks to this, original act did not have much funding for this - not sure what it looked like back then, criminal enforcement written, 2021 Act position allocated 1 FTE dedicated to enforcement and site visits (inspection and compliance checks), additional $400,000 was allocated for. Plan to add more personnel to do this.

   Less random, but targeted random checks - range of areas to cover, but choose location with specific aspects - large facility, compliance issues in the past

7. Is it possible to visit all the sites in the state (in a year, or over 2 years)? If not, how can you determine which sites need to be visited?
   CA: No, this will take quite a while, 1 site = 40 hrs, not focused on one regulation, inspections done for all potential violations - hazardous waste, universal waste, etc. Take a sample of collection sites etc. - stratified sampling

   8/9/11 months contacts - if not response they will just go pick it up anyway. TRC makes calls

8. Do you have any reports after the 2017 changes that can help us better understand the importance of site visits? Can we use this in our reporting?
   CA: Probably won't show anything from DTSC efforts, possibly just from TRC reports

9. We are considering mandating HHW facilities to be part of our recommendation based on your experience in California. Is this feasible?
   CA: It is feasible, MTs fall under universal waste - HHW facilities are up to date on how to handle these wastes so it not a big issues

10. Do you have any documents that you could share with us regarding the spike associated with site visits?
    CA: Compliance data. No extra documents to show the importance/impact of site visits

11. Is there anything else you wish to share with us?
    CA: Change from 2008 to 2021 - 3rd parties were required to supply collection bins to sites at no cost, that should motivate more collection sites to be involved.

    3rd party for ed and outreach and planning - no incentive for the 3rd party to minimize collection - removes TRCs interests from this aspect

Appendix III-b: Maine Interview Questions and Responses

1. Tell us more about the drop off system for multiple thermostats. Why use a 10 bag system?

ME: Causes a discrepancy between rebates paid. Why use a paper system would be better to use on online system

2. How long is the turnaround time from TRC when mailing money directly to an individual that dropped off at the the wholesaler/Muni/contractor
   ME: A couple of weeks
3. Who helped set up the stores? Was there any education done by the department or TRC
   ME: DEP staff went out and asked. CET will send a guy to select sites. Staff turn over or stores are just bad at transferring over the program
4. Is signage effective?
   Some take in more than others. Consider sites near contractors. Those that deal with them aot know where to take them
   NEMA (https://www.nema.org/), Manufacturers associations.
   TRC broke off but is at the will of NEMA
5. Could you tell us more about Danielle Myers and other TRC Staff?
   ME: Danielle is helpful and responsive. She works for TRC but she is responsive, less nonsense/run around
6. Is there anything else you wish to share with us?
   ME: Include a financial incentive, it has a dramatic impact

Appendix III-c: Vermont Interview Questions and Responses

1. Can we receive copies of the quarterly TRC reports since 2016 and a copy of the report on the retail pilot?
   a. Were retail locations included in the program after this?
      VT: Data is available through NEWMOA and in yearly TRC reports

2. What was the process like to include solid waste facilities to provide the rebate (incentive) for recovered thermostats?
   VT: It was easy but most of the time it was not necessary as the hhw events were larger and included a large variety of items

3. Were/are you the only staff member working on mercury thermostat recovery in VT? If so, do you feel you need more assistance/resources?
   VT: Yes. Only on the set up staff time is needed to go to wholesalers
   We could use fact sheets and contract out the set-up process

4. How much of an impact did working with Efficiency Vermont have on thermostat recovery rates? (e.g. was there an increase in response to their promotions?)
   VT: Yes they helped develop connections with contractors

5. How effective would you consider the VT landfill ban? How was/is it enforced?
   VT: The individual recours recovery were essential

6. How did manufacturers respond to the sale restriction if not collecting mercury thermostats?
   VT: It was never a problem. Daniel Myers at TRC was a big help. In 2010 we had a clause that made it so TRC had to recycle 65% of estimated coming off the walls (Extrapolated from Maine).
   Instead of pushing TRC, we worked with them. This created an agreement to have them visit all sites every other year. Made TRC do direct mailings to individual sites that are not cooperative. Making TRC stabilize a brand so it did not change every year.

7. Of the hardware stores contacted/informed of the program, how many participated? Were there any benefits/incentives for private hardware to participate?
   VT: Ace was better because they are a franchise.

8. Can you provide us with the contact information, resources about, or the website link for the EPR group?
   a. Do you have any examples of their joint advertising efforts?
      VT: All 5 EPR programs are free to the drop offer
      Manufacturers pay for everything
      Ran radio and newspaper adds
      Front porch forum
      All EPR in one spot: https://dec.vermont.gov/waste-management/solid/product-stewardship
      If allfree you could combine advertisement

9. Did TRC hire SKumatz economic research Association to estimate the thermostat outflow and did you notice any shortcomings of the methods they used?
   VT: SERA's estimate of 90,000 off NY walls each year is ridiculously high. Their estimate can't be that wrong, there is definitely more in NY than VT, but that still seems high.

Additional Notes from interview with Vermont:

- Check NEWMOA and TRC reports for more data
- California, Rhode Island and Maine are doing a mercury thermostat report to figure outlet what is on the walls
- Electric thermostats have that 3rd wire
- TRC should be integrated with mercury thermostats on a voluntary basis to save money and get the numbers at hhw
- Make an advisory group of the individual municipalities that work together, quarterly
- Bins are to big for smaller sites
- Weatherization people are a really good estimate
- Foot traffic in stores is not necessarily improved by mercury thermostats tack back
- If manufacturer is not participating their retailer can't participate
- Bag stuffers were really helpful
- Need to hold TRC to a higher standard

- Need to have a cost incentive (maybe no cost to consumers)
- Where are the majority of the thermostats coming from?
- Need more and diverse locations
    - Try to get as many municipal site involved
    - Can't expect wholesalers to be enough
- If you take them back where you buy them
- Include a minimum requirement for # locations to include
    - 1 location per 10,000 people and 3 per county

Appendix III-d TRC interviews

General/Broad Questions

1. Who at TRC is responsible for reporting is it just you and Mr. Vasami?
   Kellen company is a company that provides work for not profits
   A Lot of the nitty gritty gets handled and helped by Kellen company
    a. Who does work get contracted out to?

    b. How often will a site get a visit?
        i. Is this done by TRC or a contractor?
            1. *Center for eco technology does all site visits in the North east*
                a. *Lauren*

    c. How does TRC decide which magazines/ publications to pursue
       Big hvac and trade shows, whole and contractors, digital ads, local hhws
    d. How did you come to the conclusion to do click-ads? Have you found these to be effective?
       Increase in web, emails, website upgrade

2. Why do you think certain counties return more thermostats than others?
   Personality. Closer to the city people are to busy to deal with recycling further away people care more about nature

   Contractors may take it outside the county to recycle

3. Why do some months return more bins than others?
    a. Follow-ups?
    b. When to do household waste events?

   Spikes could be due to changes in season. When the air/heat comes on.

   Activities and events show a great return rate including site visits

4. What type of consumer is returning thermostats to wholesalers? If any?
   Home owners usually don't know about these stores

HHW waste sites are hesitant because they don't necessarily find it valuable

5. How are contractors used in the collection process?
    a. How do they get involved in the program? Is it for their personal/business use or for others to use as well? Etc.
    Any contractor can have them as long as they are using them there is no restriction

NY Questions

6. What has TRC's experience been working with the NYSDEC? Have they met their goals and understood expectations?
    When we find wholesaler locations that are not participating we would appreciate more enforcement

7. Do you think the distribution/quantity of bins is sufficient in NY?
    I think so on a general level yes all the counties are hit

8. Why has there been a decrease in thermostats collected per and an increase in the total number of bins in NY and nationally?
    a. Did the bin size change or has there been another phenomenon?
    The difference is we are seeing more collection sites and a decreasing collection rates so the total collection is being spread out to other bins

9. Do you have any contacts at Homeserve USA or the other top performing sites that we may reach out to?
    a. In NY and other TRC-participating states?
    Collection sites that have switch out programs tend to see a way higher recycling rate

10. Why is there no/limited collection data from the major NYC counties (NYC, Bronx, Queens, Kings and Richmond)?
    a. 2017 was a decent reporting year in these counties, all others (2014-2021) were sparse/lacking
    No int. Contractors out of area
    These areas care less

Other States/Data Sources

11. Is TRC doing anything differently in other states (excluding NY)?
    a. Advertising, financial incentives, bin distribution, policies, etc.

    b. Follow up with how effective these things were
    Combined advertising in vermont has been quite powerful

Activities are the same

12. How effective have financial incentives been in other states TRC works with?
    a. How does this affect your budget?
    b. California has shown that no matter what the type of incentive there has not been an effect on recycling rates
    c. Claims that there is no evidence because Maine and Vermont had it in the beginning
13. How effective has the inclusion of retail locations been in increasing thermostat collection rates in other states?
    Yes want more diversity but its difficult to get them on board

14. What is TRCs perception of the SERA estimates?
    a. Response bias

    b. Sample Size

    c. Other issues TRC has?

    TRC would be happy to work with another study

    Send follow up email these are these issues we found what were your thoughts?

Massachusetts for Florida were best voluntary programs

IA bill sunset, but collections rates were maintained

I have been with TRC since 2016. 14 states with the mandate.

In Iowa nothing changed after the sunset date

See a bump when it's required but most people don't drop collections because most people don't know about the changes so things just go as per usual.

Additional question for TRC/Danielle:

- *Units for volume of mercury?*
- *Is there a similar trend in other major cities surrounding unwillingness/interest in participation? If not, why is this the case?*
- *SERA reports - we share our issues and allow her to comment/see if she agrees/ is there something different they do not agree with?*